JPRS-USP-84-001

26 JANUARY 1984

19980921 161

# USSR Report

## SPACE



FBIS FOREIGN BROADCAST INFORMATION SERVICE



108

## NOTE

JPRS publications contain information primarily from foreign newspapers, periodicals and books, but also from news agency transmissions and broadcasts. Materials from foreign-language sources are translated; those from English-language sources are transcribed or reprinted, with the original phrasing and other characteristics retained.

Headlines, editorial reports, and material enclosed in brackets [] are supplied by JPRS. Processing indicators such as [Text] or [Excerpt] in the first line of each item, or following the last line of a brief, indicate how the original information was processed. Where no processing indicator is given, the information was summarized or extracted.

Unfamiliar names rendered phonetically or transliterated are enclosed in parentheses. Words or names preceded by a question mark and enclosed in parentheses were not clear in the original but have been supplied as appropriate in context. Other unattributed parenthetical notes within the body of an item originate with the source. Times within items are as given by source.

The contents of this publication in no way represent the policies, views or attitudes of the U.S. Government.

## PROCUREMENT OF PUBLICATIONS

JPRS publications may be ordered from the National Technical Information Service (NTIS), Springfield, Virginia 22161. In ordering, it is recommended that the JPRS number, title, date and author, if applicable, of publication be cited.

Current JPRS publications are announced in Government Reports Announcements issued semimonthly by the NTIS, and are listed in the Monthly Catalog of U.S. Government Publications issued by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Correspondence pertaining to matters other than procurement may be addressed to Joint Publications Research Service, 1000 North Glebe Road, Arlington, Virginia 22201.

JPRS-USP-84-001

26 January 1984

# USSR REPORT

# SPACE

## CONTENTS





[III - USSR - 21L S&T]

INTERPLANETARY SCIENCES

LIFE SCIENCES



SPACE ENGINEERING



SPACE APPLICATIONS

LAUNCH TABLE

MANNED MISSION HIGHLIGHTS

MANNED FLIGHT CHRONOLOGY

[Editorial Report] The Soviet News Agency TASS reports the following information on activities connected with manned spaceflight activity.

3 Oct 83 - "Substantial Changes" in Flight Program
Substantial changes are being introduced this week in the program of cosmonauts Vladimir Lyakhov and Aleksandr Aleksandrov. In their fourth month in orbit the cosmonauts will concentrate on experiments to obtain new semiconductor materials and biologically pure substances for medicine. Previous mi sions have shown that at this stage crews tend to show a certain decline in their activity. A change from routine should help the cosmonauts to readapt faster. (Moscow World Service in English 0800 GMT 3 Oct 83)

6 Oct 83 - Materials Studies
A large part of the preceding week was devoted to materials studies. A series of experiments was performed with the "Pion" apparatus. Studies were made of the mixing of gaseous occlusions in an unequally heated liquid under the influence of thermocapillary forces. An experiment was performed to evaluate directly aboard the station the condition of construction materials which had been exposed to open space. Material samples were exposed in the station's lock chamber and then evaluated with the "Elektrotopograf" apparatus. The cosmonauts have also performed visual observations and worked with the "Tsvet-1" colorimetric instrument. Today's experiments include use of the "Pion" to study intensity and developmental time of thermocapillary convection in a liquid during heating. Tomorrow the crew will have a day of rest. (Moscow PRAVDA in Russian 7 Oct 83 p 1)

14 Oct 83 - 110 Days in Orbit
Cosmonauts Lyakhov and Aleksandrov have been in orbital flight for 110 days. The program of the preceding week was devoted mainly to materials studies and biomedical experiments. The second series of "Elektrotopograf" experiments has been completed. These experiments represented an expanded program developed by specialists using results from samples and electrotopograms returned to earth by the descent craft of "Cosmos-1443". In these experiments, photographic films more sensitive to the electrical field were used and the time of exposure of the samples in open space was increased. The cosmonauts photographed the samples under investigation with color film and determined their color with the aid of a visual manual colorimeter and a color atlas aboard the station. Yesterday the crew used the "Pion" unit to grwo an indium crystal by drawing it from a melt through a forming device.

The crew monitored and made motion pictures of the process of crystal formation. The crew members also underwent a medical examination in recent days. (Moscow PRAVDA in Russian 15 Oct 83 p 1)

20 Oct 83 - Launch of "Progress-18"
At 1259 hours Moscow time on 20 October the "Progress-18" automatic cargo ship was launched in the Soviet Union. The purpose of the launch is to deliver to the orbital station expendable materials and various cargoes. Initial parameters of "Progress-18" are: apogee, 269 km; perigee, 193 km; period, 88.8 minutes; inclination, 51.6°. (Moscow PRAVDA in Russian 21 Oct 83 p 1)

22 Oct 83 - Docking of "Progress-18"
"Progress-18" docked with the station at 1434 hours Moscow time on 22 October. "Progress-18" docked at the station's service module. The cargo ship carries fuel, equipment, research materials, life support equipment and mail for the crew. (Moscow PRAVDA in Russian 23 Oct 83 p 1)

28 Oct 83 - Four Months in Orbit
Cosmonauts Lyakhov and Aleksandrov have been aboard the station for four months. During the past week the crew has been unloading "Progress-18" and performing scheduled maintenance operations on the station. A series of geological studies was also performed with the multizonal MKF-6M camera, the MKS-M spectrometers and "Spektr-15". "Progress-18" delivered updated components for the "Tavriya" unit and on 25 October an experimental batch of specially pure protein preparation was obtained. One day last week was devoted to medical examinations, including study of cardiac activity at rest and under measured physical loads. (Moscow PRAVDA in Russian 29 Oct 83 p 2)

1 Nov 83 - Cosmonaut EVA, Installation of Solar Battery
In accordance with the program for providing long-term operation of the "Salyut-7" station, cosmonauts Lyakhov and Aleksandrov have completed complex installation and assembly operations in open space. The aim of these operations was further development of methods and techniques for conducting installation and assembly work in space for creation of composite orbital complexes. The cosmonauts exited into open space and installed a supplementary solar battery in order to increase the electrical power supply of the station. Performance of these operations was planned when the "Salyut-7" station was created. Special structural elements, attachments and attachment devices were included on the station hull. The supplementary solar battery was delivered to the station by the "Cosmos-1443" ship-satellite. The cosmonauts went into open space at 0747 hours Moscow time and withdrew from the transfer compartment a container with the additional solar battery stowed inside. They then moved the container to the work area in open space. Using special mechanisms and tools the cosmonauts worked for a period of two hours and fifty minutes on the complicated and laborious operations to install and deploy the supplementary solar battery. After completing the planned work the cosmonauts returned to the main compartment of the station. Cosmonauts Lyakhov and Aleksandrov performed all planned operations in accordance with the schedule and displayed courage and a high degree of

professional training. This operation confirms the correctness of the design solutions and methods for working in open space which have been developed in ground simulators and the water tank simulating weightless conditions. These successfully completed assembly operations represent a new stage in the mastery of space and open wide prospects for further development of manned orbital complexes. (Moscow PRAVDA in Russian 2 Nov 83 p 1)

3 Nov 83 - Second EVA, Second Battery Installed
On 3 November cosmonauts Lyakhov and Aleksandrov performed a second EVA to install a second supplementary solar battery. Work began at 0647 hours Moscow time on 3 November and continued for two hours and fifty-five minutes. The complex operation was carried out by the cosmonauts in close interaction with specialists at the Flight Control Center. Before the flight the crew's activity had been practiced in the water tank at the Gagarin Cosmonaut Training Center. During the EVA's the work of the cosmonauts was simulated in the water tank by test personnel following the cosmonauts' work schedule. Total time in space during the two EVA's was five hours and forty-five minutes. The successful completion of this work has increased the electrical power supply of the station and has made it possible to substantially expand the program of scientific and technical experiments. The crew's work in open space confirmed the high reliability of their spacesuits which provide normal conditions for work outside the station. These installation operations have demonstrated the future prospects for the technology which has been developed for assembly of large-dimension constructions in space as well as the correctness of the design solutions adopted and the methods for such operations. (Moscow PRAVDA in Russian 4 Nov 83 p 1)

5 Nov 83 - 132 Days in Orbit
Today's schedule includes unloading of "Progress-18", biomedical experiments and training with the "Chibis" vacuum suit. In preparation for refueling of the station the pumping of compressed nitrogen from the oxidizer tanks has begun. The "Tavriya" unit will be used today to perform a biotechnical experiment to obtain a highly pure protein preparation. The crew will also perform maintenance operations on the station including replacement and adjustment of individual units of scientific apparatus. A trajectory correction was performed yesterday; present orbital parameters of the complex are: apogee, 356 km; perigee, 326 km; period, 91.1 minutes; inclination, 51.6°. (Moscow PRAVDA in Russian 6 Nov 83 p 1)

10 Nov 83 - Final Operations with "Progress-18"
The cosmonauts have practically completed unloading of "Progress-18". Pumping of drinking water into the tanks of the station has been completed. The station's unified engine unit has been refueled with fuel and oxidizer. Today the cosmonauts will transfer used equipment to the cargo compartment of "Progress-18". Work continues with the "Oazis" unit with electrostimulation of plants. Experimental subjects here are radish and arabidopsis. Genetic research with tomato shoots is being carried out in the "Svetoblok-M" apparatus. In the "Svetoblok-T" unit a biotechnical experiment has been completed to study possibilities for increasing the efficiency of electrophoretic separation of complex biological substances. (Moscow IZVESTIYA in Russian 11 Nov 83 p 1)

13 Nov 83 - Undocking of "Progress-18"
At 0608 hours Moscow time on 13 November the automatic cargo ship "Progress-18" undocked from the "Salyut-7"--"Soyuz T-9" complex. All planned operations with "Progress-18" had been fully completed. In addition, a trajectory correction of the orbital complex had been performed using the engine of "Progress-18". The cosmonauts are in the 140th day of their flight. Today the crew is resting. (Moscow PRAVDA in Russian 14 Nov 83 p 1)

16 Nov 83 - Destructive Reentry of "Progress-18"
At 0718 hours Moscow time today the engine of "Progress-18" was activated by command from the Flight Control Center. The ship entered the atmosphere over the planned area of the Pacific Ocean and ceased to exist. In recent days the cosmonauts' flight program has included geophysical research, work on methods of recording technological processes with holographic apparatus and training with the "Chibis" vacuum suit. (Moscow PRAVDA in Russian 17 Nov 83 p 1)

18 Nov 83 - 145 Days in Orbit
Cosmonauts Lyakhov and Aleksandrov have been in orbit for 145 days. The planned research program is nearing completion. Today's schedule includes me surement of atmospheric parameters near the orbital complex and a number of technical experiments. There will also be training with the "Chibis" vacuum suit which simulates earth gravity. In the days immediately ahead the cosmonauts will begin preparations for return to earth. They will perform deactivation operations on the "Salyut-7" station and will store research materials in the "Soyuz T-9" transport ship. The cosmonauts are in good health and are feeling well. (Moscow PRAVDA in Russian 19 Nov 83 p 1)

21 Nov 83 - Flight Program Completed
Cosmonauts Lyakhov and Aleksandrov have fully completed the program of research and experimentation aboard the orbital complex and have begun preparations for return to earth. Today the crew is carrying out planned operations to store scientific apparatus and deactivate onboard systems of the station. They are also taking samples of air and microflora for subsequent laboratory analysis. Containers with research materials are being stowed in the descent craft of "Soyuz T-9"; used equipment is being placed in the ship's orbital compartment. The crew has checked the working condition of the onboard systems of "Soyuz T-9" and has performed a test switch-on of the ship's engine unit. According to telemetry measurements and reports from the crew onboard systems of "Salyut-7" and "Soyuz T-9" are functioning normally. Preparations for return to earth are proceeding strictly in accordance with the planned schedule. (Moscow IZVESTIYA in Russian 22 Nov 83 p 1)

23 Nov 83 - Cosmonauts Return
Cosmonauts Lyakhov and Aleksandrov have successfully completed the program of their 150-day flight. At 2258 hours Moscow time on 23 November the cosmonauts returned to earth. The descent craft of the "Soyuz T-9" landed in the planned region of the Soviet Union 160 kilometers east of the city of Dzhezkazgan. The cosmonauts felt well after the landing. Significant results were achieved in the flight in the following areas:

--geophysical research: collection of a large volume of statistical material on natural resources, atmospheric conditions, seasonal changes in agricultural lands and biological productivity of the oceans

--materials studies: new semiconductor materials with improved characteristics were obtained in the "Kristall" apparatus; a series of experiments was performed with the "Pion" unit to study features of physical processes in weightlessness; the "Elektrotopograf" instrument was used to study directly aboard the station the condition of structural materials exposed to open space

--biotechnical research: experiments in the "Tavriya" unit to obtain highly pure proteins; experiments in plant cultivation were continued

--assembly operations: two EVA's were performed for installation of additional solar batteries to increase the electrical power supply of the station

--medical studies: medical examinations of the cosmonauts provided new data confirming the possibility for active human activity in weightlessness and in open space; these data will be used in determining optimum regimens of work and rest for cosmonauts on manned stations

--technical experiments: further development of methods of control for orbital complexes; tests of instruments and equipment for future space apparatus

Results obtained from the 150-day flight will find application in many areas of science, technology and the national economy. (Moscow PRAVDA in Russian 24 Nov 83 p 1)

CSO: 1866/50-P

'PIRAMIG' AND 'PCN' EXPERIMENTS

Moscow ZEMLYA I VSELENNAYA in Russian No 2, Mar-Apr 83 pp 13-17

[Article by G.M. Nikol'skiy, doctor of physico-mathematical sciences: "Astrophysical and Geophysical Studies"]

[Text] From 26 June to 1 July 1982 studies were conducted aboard the "Salyut-7" orbital station by a Soviet-French crew. The research program included astrophysical, geophysical and medical-biological experiments. The content of and some of the results from the experiments are described in the articles [as published] below.

During the flight, astrophysical and geophysical observations were carried out using two installations, the "Piramig" and the "PCN." (see ZEMLYA I VSELENNAYA No 3, 1982, p 12--ed). "Piramig" is an acronym for Proche InfraRouge Atmosphere Milieu Interplanetaire et Galaxies--the Near-Infrared Field of the Atmosphere, Interplanetary Medium and Galaxies. PCN is Photographie du Ciel Nocturne--Photography of the Night Sky. The "Piramig" camera was equipped with an electronic image intensifier. In regular image converters electric or magnetic electron focusing is used. But in the "Piramig" camera use was made of an electronic fiber optics analog. Each "fiber"--this is a thin (up to 20 micrometers) tube--acts operating as a photomultiplier in which electrons are propagated along the tube and amplified as they are reflected from its walls. The amplifier consists of several million "fibers" gathered into a cylindrical bundle; a photocathode and a screen are mounted on the end of each cylinder. Different potentials are applied to the fibers accelerating the electrons. In total, this microchannel image intensifer has an intensifying coefficient of about 1,000 and a resolution of about 0.05 to 0.10 millimeters; this is determined by the number of tubes per unit of area. The photocathode in the microchannel intensifier is sensitive within the spectral range 1,000 to 250 nanometers. Photographic film is pressed against the screen for recording. The diameter of the useful field is 40 millimeters. The "Piramig" apparatus is equipped with a set of filters that separate out the different spectral fields, from the near-infrared to the ultraviolet. The lenses used have a focal distance and intensity of 58 mm/1.2 and 180mm/2.8. Using a keyboard-type composer the camera can be set up for any required exposure time and a note is made on each frame of the date, time and exposure time. The "Piramig" camera was developed at the Marseille space astronomy laboratory.

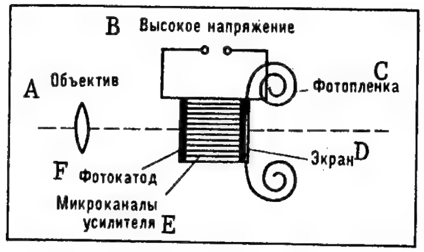



Figure 1. Basic Layout of "Piramig" Camera.

Key:

- A. Lens
- B. High voltage
- C. Film
- D. Screen
- E. Microchannel image intensifier
- F. Photocathode

* * * * *

The PCN installations consists of a high-quality camera with interchangeable 58mm/1.2 and 135mm/2.0 lenses mounted on an azimuth stand and equipped with a small viewfinder tube for guiding. Guiding can be done manually along two axes within the range ±2.5°. Very sensitive black-and-white and color reversible film is used for PCN. The date and time is marked on each frame. The PCN installation was fabricated by the Paris Astrophysics Institute.

A little on the history of the PCN experiment. As long ago as 1978 pilot-cosmonaut of the USSR G.M. Grechko on the "Salyut-5" obtained the first black-and-white pictures of zodiacal light in the upper layers of the Earth's atmosphere. Later, pilot-cosmonaut of the USSR V.V. Ryumin took a large number of pictures of the same objects on color reversible film. The success of these observations served as the basis for preparing the PCN experiment. The USSR Academy of Sciences Institute of Terrestrial Magnetism, Ionosphere and Radiowave Propagation and the Paris Astrophysics Institute proposed and prepared the PCN experiment for the scientific program conducted by the Soviet-French crew. Observations aboard the station were carried out with the active participation of the entire crew (A.N. Berezovoy, V.V. Lebedev, V.A. Dzhanibekov, A.S. Ivanchenkov, and J-L. Chretien). The scientific chiefs for this experiment were (S. Kuchmi) (Paris Astrophysics Institute) and the author of this article.

The main tasks of the observations on both the installations were to study the interplanetary medium (zodiacal light) in various spectral bands; determine the brightness of the night sky background and those sections of it containing minimum illumination by zodiacal light and the Milky Way; to photograph the Andromeda Nebula and the Magellanic Clouds; to study luminescence in various fields in the ionosphere; to study luminous clouds; to study lightning; and to photograph hdyroxyl in the near-infrared in the Earth's atmosphere, mainly by recording the spatiotemporal changes in this illumination--the "OH waves." All objects were photographed on the night sections of the station's orbit.

A special instrument--a sensitometer--was designed by the Paris Astrophysics Institute for absolute references for the brightness of objects.

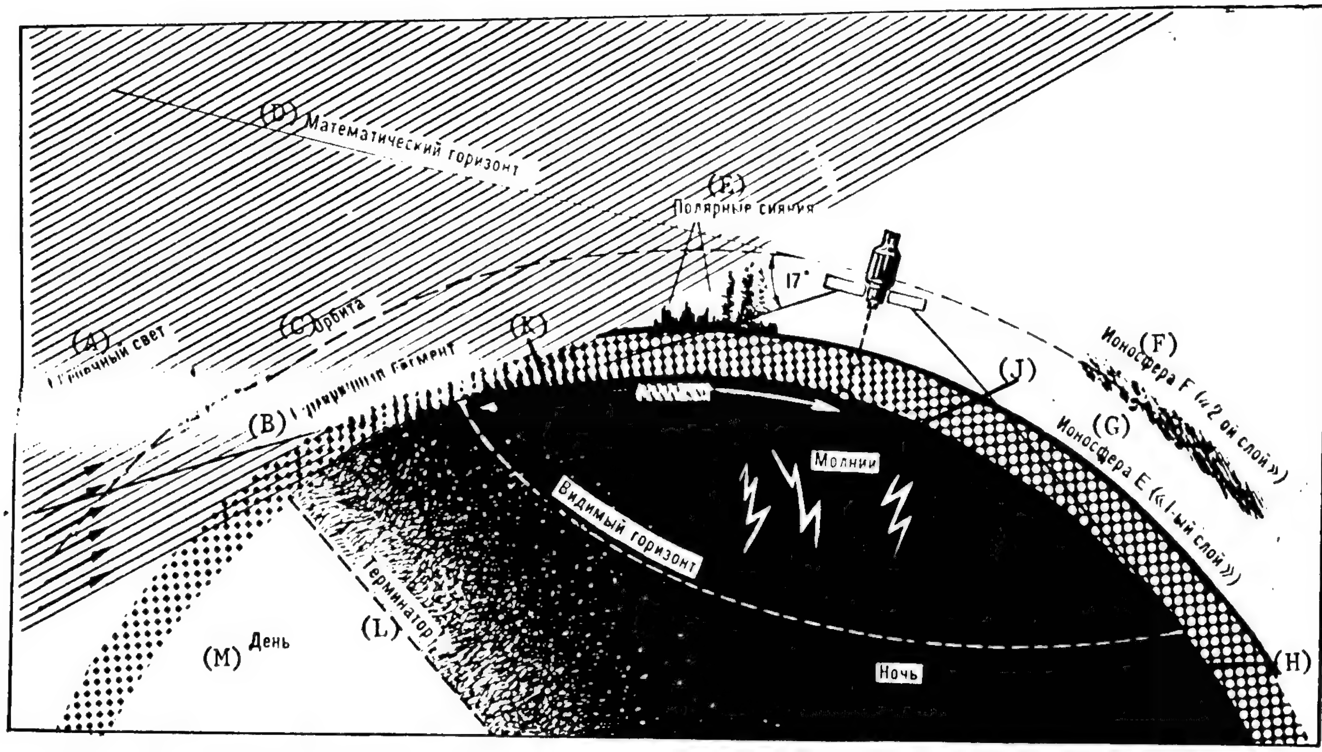



Figure 2. Diagram Showing Observation Features from the "Salyut-7" Orbital Station.

The station is on the night side of the Earth. The visible horizon is 17° lower than the observer's horizon (the height of the orbit is 300 km above the Earth).

Key:

| | |
|---|---|
| A. Solar light | G. E Ionosphere ("1st layer") |
| B. Twilight segment | H. Night |
| C. Orbit | J. Lightning |
| D. Observer's horizon | K. Visible horizon |
| E. Polar aurora | L. Terminator |
| F. F Ionosphere ("2d layer") | M. Day |

Observations from an orbital station have a number of specific features. First of all, the days last 1.5 hours, and in orbit, taking into account that the visible ("hard") horizon is 17° lower, the nights last a little over half an hour. Astronomical objects shift at an angular rate of 4°/min relative to the horizon. Therefore, with long exposure times (up to 5 minutes in the PCN experiment) it is necessary to orient the station on the stars. For observations of luminescence in the Earth's atmosphere above the visible horizon it is necessary to insure that the station does not move relative to the direction of orbital movement. The lines--tracks--on the film will be cut out depending on the angle between the direction of the station's movement and guiding by the stars.

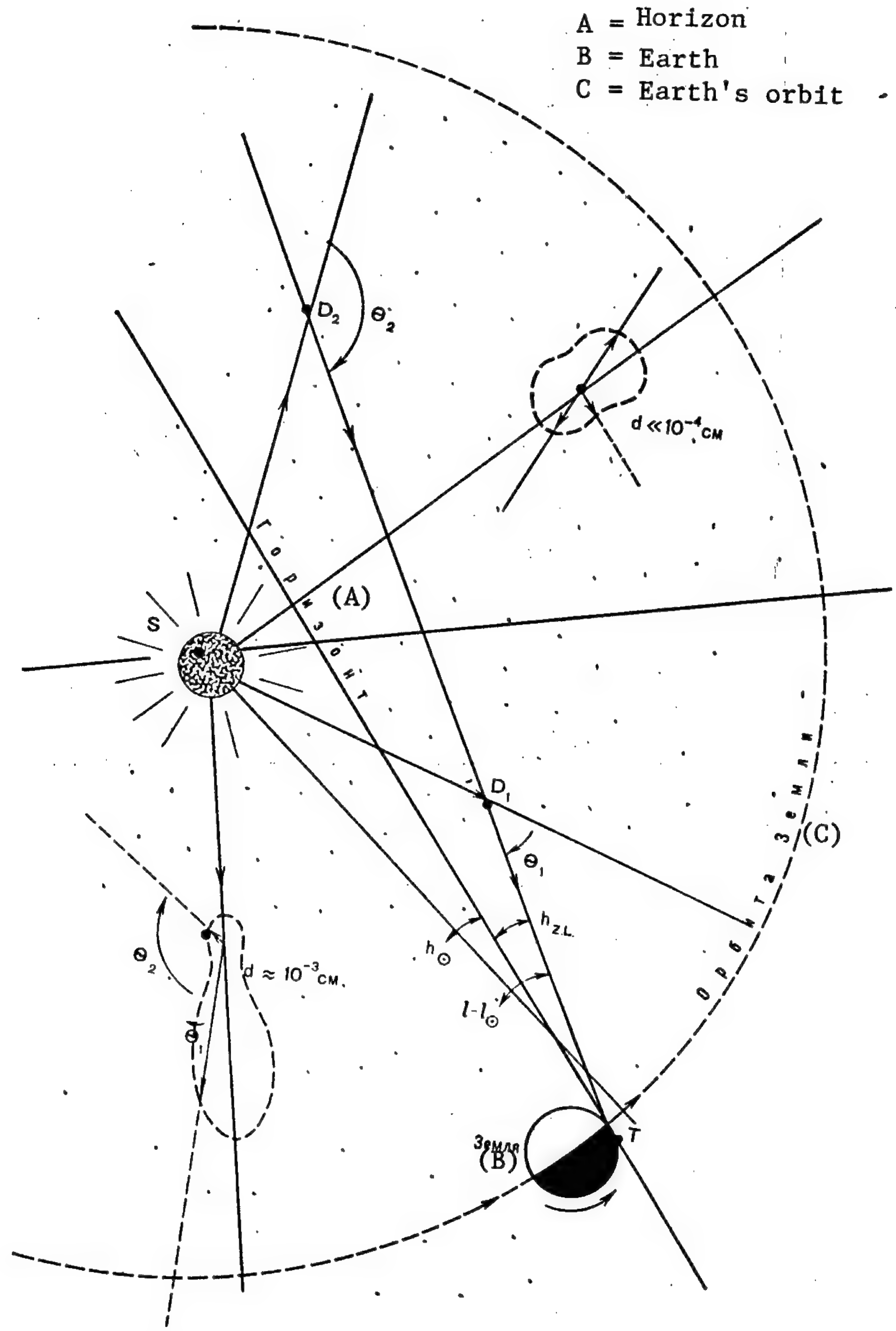



Figure 3. The Formation of Zodiacal Light from the Viewpoint of a Ground Observer at Point T.
The plane of the drawing matches the ecliptic plane. Indicatrices are shown for scatter of solar light by interplanetary particles. Dust particles of about 0.001cm scatter light intensely at small angles, i.e., "ahead" (light diffraction) and "behind" substantially less. Small particles and molecules have an indicatrix close to the spherical. It is thought that particles of 0.001 cm predominate in interplanetary space (concentration about 10 per $1km^3$). Therefore the main contribution to zodiacal light comes from dust particles between the Sun and the observer.

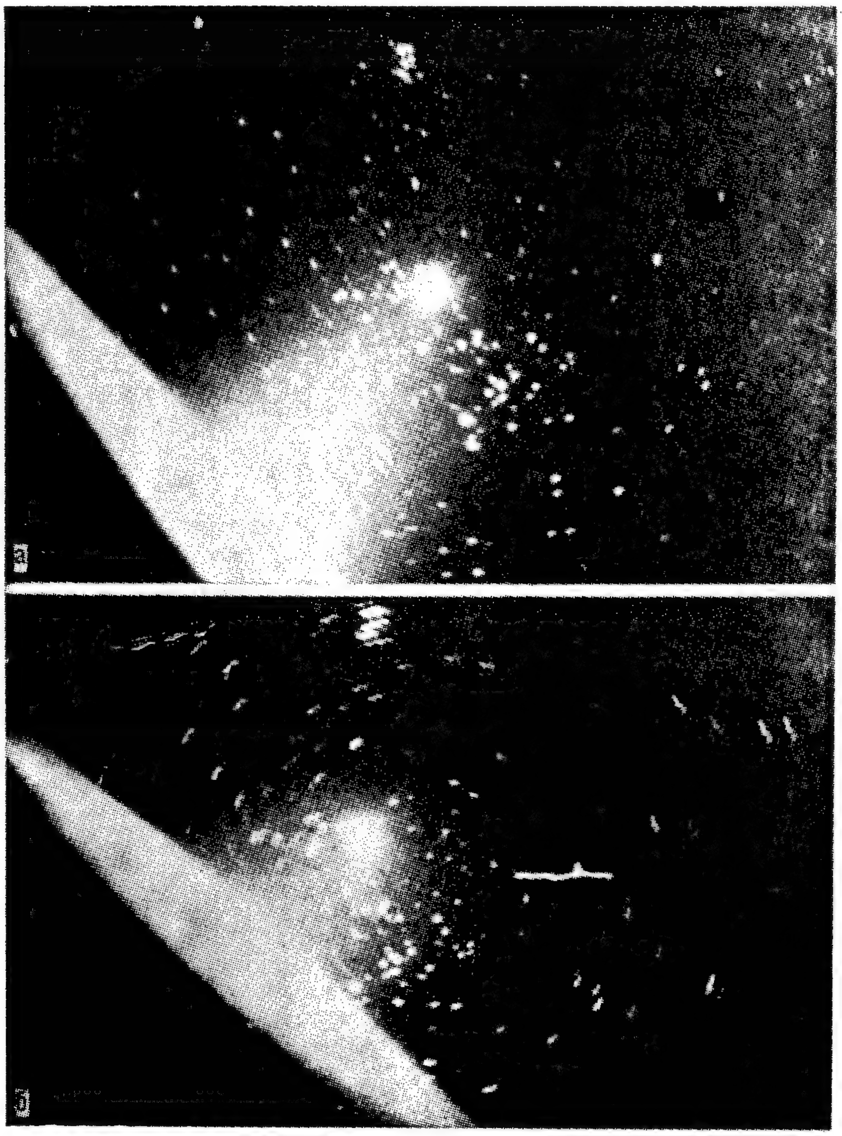
In the PCN experiment preference was given to color film. Three-layer 35mm "Ekta-400" with a sensitivity of 400 units for short exposures was usually used. Color photography enables conclusions to be drawn about the spectral composition of radiation from objects with only a cursory examination. One color shot is in fact the equivalent of three pictures taken through red, green and blue filters. Quantitative analysis of color pictures is a quite complicated procedure: photometry through three filters, taking account of the spectral sensitivity of each of the layers of emulsion, and interlayer effects associated with the light-sensitive layers when photographic materials are developed. In space, where it is impossible to repeat shots in the same conditions, three-layer photographic emulsions offer considerable advantages. In particular, the advantages are marked in pictures of ionospheric luminescence. This is because the characteristic lines of emission waves in the upper layers of the Earth's atmosphere are known. They are usually "forbidden" oxygen emissions with a wavelength of 557.7 and 630 nanometers, resonance sodium radiation with a wavelength of 596 nanometers, and lines of molecular oxygen and nitrogen ions. Accordingly, green light in the E layer of the ionosphere (at a height of 100 km) indicates a dominant role for neutral oxygen (OI) radiation at 557.7 nm, while red light in the luminescence from the F layer (at heights of 250 to 300 km) points in this case to (OI) lines at 630 nm.

When studying zodiacal light it is important to establish whether the light (spectral composition) of scattered interplanetary dust in solar radiation is different from solar light. This is because whether or not the scatter is neutral, that is, without change in the spectral composition of radiation after interaction with dust particles, or whether scattered radiation becomes more blue (or more red) depends on the typical size of interplanetary dust particles and their shape.

Besides the specifics associated with the rapid movement of the orbital station around the Earth, observations from space are also different from ground observations because other objects are visible and the observation difficulties are different.

During ground observations of zodiacal light the main source of interference is the final brightness of the sky, which is comparable to the brightness of zodiacal light itself; and observations are possible only when the Sun is well below the horizon (at least 18°). On the other hand, the increasing absorption by the Earth's atmosphere toward the horizon makes accurate measurements of the brightness of zodiacal light virtually impossible at small angular distances from the Sun ($I-I_0$ less than 25°). Moreover, absorption depends on the wavelength of the radiation (in the blue wavelengths it is greater than in the red). The sky in space is considerably darker and, it would seem, it is enough merely for the Sun to go below the horizon in order to make observations. But the twilight segment of the Earth's atmosphere is very bright, and by being scattered in the glasses of the porthole and in the lens, its light interferes with observations. In a practical way, from a space station it is possible to observe only when the Sun has moved at least 10°-15° below the horizon. True, the absence of an absorbing medium--the Earth's atmosphere--makes possible accurate measurement (of changes) in the brightness of zodiacal light depending on the angular distance to the Sun (from ecliptic longitudes and latitudes). According to data from ground observations, the interplanetary dust cloud is

lens shaped with a plane of symmetry matching the ecliptic plane. The question of the orientation of interplanetary cloud cannot be considered finally resolved. The change in light absorption in the Earth's atmosphere close to the horizon makes it impossible to do this even by numerous ground observations. It should be noted that at the moment of observation of the zodiacal light by the Franco-Soviet crew, the planet Venus was at maximum possible angular distance from the ecliptic, and this made it possible to establish that the plane of symmetry in the interplanetary cloud does not match the plane of the ecliptic.



Photographs of the zodiacal light taken 30 June 1982.

It is visible as a foggy projection stretching to the horizon of Venus (Venus is the very bright object in the center of the picture). On picture b, taken when the Sun was well below the horizon, the track of a moving Earth satellite can be seen (the bright line in the right of the picture)

Figure 4

We noted that the sky in space is dark. But how much more dark than the sky from Earth is it? This must be known for the future of telescope astronomy. Is it possible by increasing a telescope's aperture ratio and the sensitivity of the radiation receiver to record very weak objects? And how weak?

The brightness of the sky in space results from two factors, namely luminescence in the medium between the observer and the observed object (the Earth's atmosphere at great heights and, mainly, the atmosphere inside the space vehicle itself), and luminescence in the galactic and interplanetary mediums (gas, unresolved stars). This is why in the astrophysics experiments provision was made for photographing the "dark" parts of the sky located close to the galactic and ecliptic poles.

This picture, taken at 1710 hours on 28 June late in the "orbital" night over the Pacific Ocean south of the Hawaiian islands, shows a gigantic lightning which during its flash (several hundred seconds) lit up an area measuring 50x30 km.

Figure 5

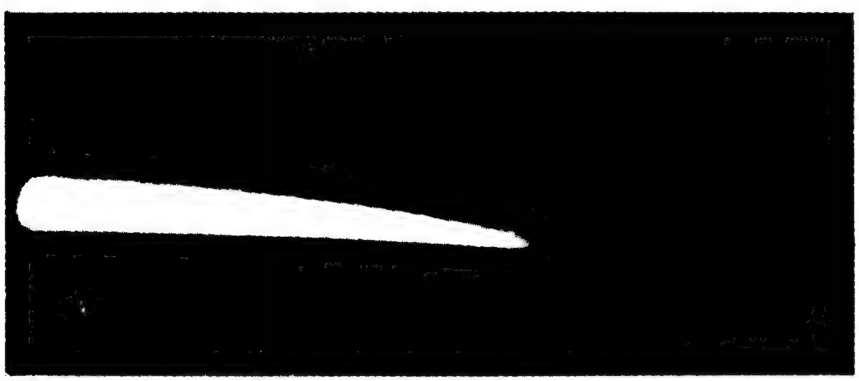


Figure 6 One of a series of photographs of luminous clouds taken 0159 hours on 30 June soon after the orbital sunrise. The space complex was above France and the luminous clouds, which could possibly be microscopic ice crystals forming in aerosols of volcanic or space origin, are located at a height of 80 km above the coast of Ireland.

The "Piramig" and PCN experiments (like all the other experiments) were conducted in conditions of great stress in the visiting expedition (VE) and the main crew (MC). As an illustration let us take a look at the cosmonauts' program for 30 June 1982.

| Time zones for radio contact* | Crew activities |
|---|---|
| 0900-0908 | Morning toilet. |
| 1035-1044 | Breakfast, "Mikrobnyy obmen" experiment. |
| 1140-1153 | Move PCN and "Piramig" equipment from one porthole to another.<br>VE: "Ekhografiya" experiment.<br>MC: Station maintenance. |
| 1313-1327 | VE: "Neptun" and "Tsitos-2" experiments.<br>MC: Physical exercises. |
| 1445-1501 | VE: "Piramig" and PCN experiments<br>MC: Orientation of complex. System monitoring. Dinner. |
| 1612-1635 | VE: "Piramig" and PCN experiments.<br>MC: Orientation of complex. |
| 1741-1806 | Talk with USSR radio commentator, prepare for television reportage.<br>VE: "Piramig" and PCN experiments.<br>MC: Orientation of complex. System monitoring. |
| 1910-1939 | Television reportage on "Physico-technical experiments"<br>Shooting movie film.<br>VE: "Piramig," PCN and "Tsitos-2" experiments.<br>MC: Orientation of complex. System monitoring. |
| 2033-2107 | Talk with French television commentator during television session. Supper.<br>VE: "Likvatsiya" experiment. |
| 2217-2238 | Familiarization with program for following day. Prpearation of daily rations.<br>Sleep from 2400 to 0900 1 July. |

* Here and throughout the article winter Moscow time is used (universal time plus 3 hours).

It should be added that over and above this program, on 30 June, in particular, pictures were taken for the PCN program from 0100 hours to 0230 hours.

When the experiments were being conducted scientists from the USSR and France were at the flight control center to maintain operational communications with the crew via the main communications operator or the flight controllers. We note that the astrophysics experiments were in fact the only ones for which orbital data on the complex were important: height of orbit, orientation of the complex relative to the movement vector, geographical coordinates. The "Salyut-Soyuz" complex operated as a space observatory: the main crew lined up the astrophysics instruments on given objects, orienting the station as necessary. This was the main difference in the astrophysics observations from the other experiments and, for example, from the Skylab, which was oriented permanently toward the Sun.

During the 3 days of observations, the "Piramig" and PCN cameras took several hundred pictures including, as a quick analysis showed, dozens of outstanding scientific interest.

The originals were passed on to French scientists and copies were kept in the USSR. Soviet and French specialists have now set about processing the materials.

The "Piramig" and PCN equipment was also operated aboard the "Salyut-7" after the end of the international flight. A.N. Berezovoy and V.V. Lebedev continued the experiments that had been started.



9642
CSO: 1866/115

COSMONAUT TRAINING

Moscow ZEMLYA I VSELENNAYA in Russian No 2, Mar-Apr 83 pp 2-7

[Article by Twice Hero of the Soviet Union, pilot-cosmonaut of the USSR A.G. Nikolayev: "Cosmonaut: the New Profession of the 20th Century"]

[Text] Twenty years of experience in training and manned space flights give grounds for asserting that cosmonauts now constitute a profession. It differs from many other professions in a number of fundamentally important ways.

This was graphically demonstrated on the eve of the 60th anniversary of the formation of the USSR by the longest flight in history--the 211-day mission of the Soviet cosmonauts A.N. Berezovoy and V.V. Lebedev. They had to be generalists: observe and photograph the Earth's surface and the watery areas of the world's oceans, study various objects in the universe, make monocrystal semiconductor materials, develop methods for obtaining superpure biologically active substances in weightless conditions, cultivate higher plants on the station, develop improved onboard systems, equipment and instruments for space apparatuses and even launch the small "Iskra-2" and "Iskra-3" satellites into space.

They displayed great knowledge, will and restraint, and they retained their work capacity right up to the end of the mission.

So how are cosmonauts trained today for their professional activities?

Over the past years dozens of main and backup crews made up of one, two or three cosmonauts have been trained. Fifty-one crews have completed space missions: 53 Soviet cosmonauts, 9 cosmonauts from the socialist countries, and a French cosmonaut--Jean-Louis Chretien. These figures, of course, do not in themselves give any idea of the enormous amount of extraordinarily varied, stressful and complex work of the cosmonauts themselves and the specialists who train them for their flights.

The unique nature of man's activity in space is associated primarily with weightlessness. Weightlessness has both its positive and negative aspects. On the one hand there is the feeling of being unshackled from gravity and of freedom of movement, and on the other there is the sensation of a rush of blood

to the head, various symptoms of "motion sickness," the impossibility of working in an unsupported space without fixation, absence of the concepts of "up" and "down" which are natural for man, and prolonged sojourns in a closed and restricted space. The process of adaptation to work in these conditions is complex: the cosmonaut must solve the problem of retaining or correcting habits learned on Earth and must develop the new habits essential for work in weightless conditions while in the vehicle or particularly when engaging in extravehicular activity.

It was necesaary to study the adverse effect of spaceflight factors on the cosmonaut's body and develop effective means for preventing and dealing with these effects. The main efforts were directed toward working out measures and means for dealing with impairments of the cardiovascular system, water-salt exchange, the skin and muscular system and the circulatory system. Scientists have developed a complex of preventive means that help to maintain health and support a high level of work capacity in cosmonauts (the treadmill, bicycle ergometer, pressure suit, vacuum chambers and others).

The specific nature of activities by the cosmonaut is also determined by the fact that he must possess different professional qualities simultaneously. Like the actor in a one-man show in a theater, the cosmonaut plays the roles of operator when controlling systems on the vehicle and of scientific worker when conducting experiments in various disciplines of science of technology; he plays the role of assemblyman and repairman for the equipment, and the role of radio operator, photographic specialists and television commentator, physician.... All this predetermines the complexity of cosmonaut training and the cooperation among organizations engaged in training.

Flight conditions also make very great demands on the cosmonaut's psyche. He must be emotionally stable and independent when making and implementing decisions, and he must approach fulfillment of set tasks creatively. And it should be remembered that the crew's autonomy and independence of action is combined with a complicated functional link in work with the flight control center. Information transmitted by the crew about the behavior of onboard systems and passing of commands to the control panel substantially supplements telemtry data received by the flight control center. Therefore, great responsibility rests with the crew for the completeness of data acquisition and its immediate transmission to Earth. This is particularly important if a deviation from normal flight occurs.

Another special feature of the profession of cosmonaut is the content of his activities. The cosmonauts acts primarily as a tester of new equipment. The achievements of dozens of branches of science and technology are concentrated together in a space vehicle. The tester is an amalgam of knowledge, professional qualities and character. Constant accumulation of experience and perfection of the essential qualities--these are the indexes of maturity in the tester. The value of the tester is subjected to special inspection during decisionmaking in complex situations. We have many examples of cosmonauts displaying their best professional qualities and coping successfully in missions with complex tasks. We need only recall P.I. Belyayev, who when he had to assumed control of the vechicle and landed the "Voskhod-2" in the region of Perm in a forest,

in deep snow. Or there is V.V. Ryumin's extravehicular activity when he had to unhook the antenna of the KRT-10 space radio telescope from the "Salyut-6." And there is A.N. Berezovoy's and V.V. Lebedev's recent extravehicular activity, which required an excellent knowledge of their business in addition to courage.

Much experience has now been gained in rendezvous of space vehicles and docking and making pressure-tight couplings. The system used to supply stations using the "Progress" automatic freighter has shown itself to be highly efficient. It has made it possible to deliver new scientific apparatus to the station on an ad hoc basis and to amend the scientific research program being conducted by the cosmonauts, taking into account the results obtained during the flight itself. The possibility has also been demonstrated of supplying a station with expendable materials and equipment used by the crew in space to complete complicated repair and preventive work to restore and replace onboard systems (in this regard, the most typical operations have been the replacement of hydraulic pumps in the heat-regulation system and unhooking the KRT-10 radio telescope antenna from the "Salyut-6" station).

One important feature of the profession of cosmonaut is its research nature. An increasing proportion of cosmonaut activities in space is now made up of research and expereimental work. It is not fortuitous that the "Salyut" orbital stations are called complex research laboratories. Cosmonauts labor in the interests of many branches of science and technology and resolve tasks of national economic significance. During the flight of the "Salyut-6" alone, when cosmonauts from the fraternal socialist countries also worked on board, about 60 astrophysics observations were carried out, 13,000 photographs taken, several hundred sessions of visual observation completed, and about 200 technological experiments conducted to obtain pure materials under weightless conditions.

When a crew is conducting scientific experiments and research, virtually no differentiation of function exists among the crew members (specialization). Today's cosmonaut is a broad-profile investigator. He acts not simply as the executor of preprescribed action but frequently has to participate in working out the method and adapting it to the new conditions, taking into account all the special features of the flight. The work of the cosmonaut aboard a station (or vehicle) is creative, active work based on deep knowledge, skill and experience. Its investigative nature makes high demands not only on the cosmonaut's professional skills but also his human qualities.

This description of the profession of cosmonaut would be incomplete if we did not talk about the state and social significance of this profession and the public interest in it. As is known, each flight into space attracts the attention of people throughout the world and is of nationwide significance. The social significance of the profession of cosmonaut is determined first and foremost by the value of the results achieved during the flight, when, for the good of people and for peace on Earth, numerous scientific, technical and national economic tasks are resolved. The labor of the cosmonaut is the culmination of the results of work by many thousands of people with different specialties, and so a sense of responsibility and high civic duty will always be inherent features of the profession of cosmonaut.

This by no means complete list of requirements for the profession of cosmonaut enables the following conclusion: only a comprehensive approach to training can insure formation of the necessary special qualities.

It is obvious that cosmonaut is one of the few professions for which it is virtually impossible to gain experience of its actual activities during the training process. The main task of the cosmonaut training system is to form professional knowledge, skill and habits by means of creating models of activity that approximate the reality as closely as possible, with reproduction of the corresponding emotional and psychic stresses during training sessions. Hence the comprehensive nature of cosmonaut training and the diversity of its means and methods.

Training cosmonauts for their professional activities is now accomplished along the following main avenues: training for control of space vehicles and orbital stations, together with operation of onboard systems; training to conduct planned scientific and technical research and experiments; training the cosmonaut's body for the effects of spaceflight factors; the formation of the cosmonaut's personality and his psychological preparation for flight.

Training for multiple-expedition space flights entails a number of special features and difficulties. This is associated primarily with the need to train a large number of crews simultaneously (including the backup crews). Second, consideration must be given to the differences in the training programs for each expedition in terms both of volume and of tasks. Third, it is necessary to coordinate in time those training tasks connected with the interaction of the crews on the main expedition and those of the visiting expeditions.

The system of cosmonaut training that has been developed today has been checked by many years of practice. The principles forming the basis of this system have been scientifically substantiated. The stages of training and its form and content have been defined.

The main kind of professional training for cosmonauts is work in special-purpose, complex simulators. In a simulator it is possible to reproduce an information model of a flight and acquire complicated profesional skills. The simulator helps to reinforce theoretical knowledge and makes it possible to realize the method of problem teaching. During simulator training all the elements and stages of the upcoming flight are worked through in their close interrelationship and interdependence, in normal and abnormal conditions.

When training cosmonauts for actions in "special" flight events, great attention is paid to modeling the psychological status. Productiveness in the purposeful development of psychological qualities depends directly on the severity of demands made of the human psyche in training and on a variety of means and methods used to exert emotional influences during training. Attention is therefore given to flying and parachute training for cosmonauts. The aircraft can be regarded as a professional simulator for cosmonauts for control of a moving object with complex effects from physical and emotional stress. Flying and parachute training for cosmonauts is very useful for instilling the habits of working in stressful conditions. It promotes the development of essential

personal, volitional and professional qualities. Flying training helps to form the ability to make decisions independently in a complex flight situation; this is particularly valuable in training the crews of space vehicles. Training in free-fall conditions and--particularly important--in conditions of autonomy and independence combined with a sense of risk, makes parachute training an important stage in the special psychological training of cosmonauts.

Training models that simulate individual spaceflight factors are of great significance in making the cosmonaut both a subject and a tester; this is done in flying laboratories, underwater laboratories, centrifuges, pressure chambers and isolation chambers, and also in training sessions when the cosmonauts learn how to act after landing in various climatic and geographical zones.

All kinds of cosmonaut training, primarily flying and parachute training, training in special-purpose and complex simulators, in pressure chambers under conditions of water-weightlessness, flights aboard flying laboratories, and in natural conditions in various climatic and geographical zones, in the aggregate make up a powerful means for forming a cosmonaut as an individual capable of carrying out complex, risk-related operations during space flight.

Political education plays an enormous role. In the CPSU Central Committee decree "On Further Improving Ideological and Political-Educational Work," which demands that our ideology be of a forward-looking nature and scientifically substantiated, we see further reserves for the moral-political training of cosmonauts. For the profession of cosmonaut was born at the cutting edge of scientific and technical progress, and cosmonauts themselves are builders of the material-technical base of communism. The successes of Soviet cosmonautics and the "Interkosmos" international program are also successes for our ideology.

Soviet cosmonauts--the bearers of the high ideals of humanity, courage and spiritual excellence--will always be worthy of their people, who first blazed the trail into space!



9642
CSO: 1866/115

BEREGOVOY ON COSMONAUT TRAINING

Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 4, Apr 83 pp 1-2

[Article by Lt Gen Avn G. Beregovoy, USSR pilot-cosmonaut, chief, Cosmonaut Training Center imeni Yu.A. Gagarin, twice Hero of the Soviet Union: "The Path to Orbit"]

[Text] The Soviet Union's contribution to the peaceful conquest of space and peaceful scientific and technical progress is a huge one. The results of Soviet experiments in space are being used for the good of all mankind. In cosmonautics today we have brought together the interests of science and production and purely theoretical and applied problems that excite scientists, designers, engineers and representatives of the most variegated specialties. Further study and mastery of space in the interests of the development of science, technology and the national economy is one of the most important problems in the field of natural and technical sciences and one for the solution of which efforts are being concentrated in this five-year plan. This is reflected in the documents that came out of the 26th CPSU Congress.

A powerful and well-organized industry has been created in the Soviet Union and Soviet science has reached a high level, occupying the leading place in the world in many fields. Behind all this stood and still stands the organizing work of the Communist Party and the Soviet government.

More than 20 years ago, the CPSU Central Committee and the USSR Council of Ministers approved scientific, technical and organizational measures for the preparation of manned flights into space and the systematic investigation and utilization of space. The Cosmonaut Training Center, which was later named for Yuriy Alekseyevich Gagarin, was set up. The Training Center became the first space academy, and an international one at that.

Cosmonauts from the fraternal countries that are participants in the international "Intercosmos" program learned the difficulties and joys of the roads in space. This includes the French cosmonaut Jean-Loup Chretien and will include the envoys from India who are preparing for a flight. The international flights into space have yielded valuable material for the scientists of the countries in the socialist concord.

The scientific investigations and experiments conducted by crews in orbit have broadened significantly our knowledge about many natural phenomena, the technology of the production of new materials, and the development of original methods and equipment for observing the surrounding medium.

Many branches of the national economy are interested in space information. It is needed by geologists and builders, fishermen and toilers in the fields, sailors and weather forecasters. Space is at the service of the national economy! Such is the main principle that is finding its practical embodiment in the program for each experiment or observation from orbit, regardless of whether or not it is related to the study of our planet's natural resources or is aimed at investigating the far reaches of the Universe. For instance, the results of observations made from orbit are also being used to formulate predictions about the cutting down of forests in some regions, protecting green spaces and other, and solving problems concerning the rational use of land and the construction of new cities and large main transportation lines. These stingy facts hide a huge amount of work and the solution of complex scientific, technical and organizational problems.

The Training Center is the same age as manned cosmonautics, and during this short period of time it has traveled a long path. It is very likely that 20 years ago the specialists' main concern was to prepare the cosmonaut's body for its encounter with an unusual environment. It was important to understand whether or not man could work as an operator in space in general. Therefore, they devoted their basic attention to preparing cosmonauts to work under conditions of weightlessness and large overloads. The thermal vacuum chamber, the centrifuge and the flying laboratory were used extensively for this purpose.

With the growth of our knowledge about space and its effect on man, we have refined our methods for training cosmonauts and created new facilities. For example, after it was discovered that a cosmonaut's blood rushes to his head during the period of adaptation to weightlessness, new training methods utilizing special devices were developed. And after the first extended flight it turned out that it is difficult for the body to get used to Earth's gravity. The specialists then found methods to ease the cosmonauts' re-encounter with Earth.

We now know that cosmonauts can stay in orbit for months. This does not mean simply flying, but also performing extremely diversified and complicated research. In order to do this they must have extensive knowledge in the most variegated fields of science and technology. This knowledge is acquired during the stage of general space training, which is conducted in groups according to an overall program. During this period the cosmonauts' individual special features are studied; this is necessary for the selection of future crews, since mutual psychological compatibility must also be taken into consideration.

Orbital stations are scientific laboratories in which only those who are thoroughly acquainted with their equipment and the experimental techniques can work. Take, for example, the space radiotelescope. Weeks are needed in order to master it. And on a station there are truly tens of instruments and installations.

The research program that cosmonauts are faced with carrying out is worked out carefully on analogs of the scientific equipment. The originators of the experiments themselves frequently play the role of teacher. By undergoing apprenticeships in scientific establishments, the cosmonauts strengthen their knowledge. In order to show the scale of all the work that is done, I will present just one figure: our Center interacts with more 300 organizations: institutes, design offices, VUZ's, enterprises.

I sometimes have to listen to the following opinion: right now it is easier and simpler to master the profession of cosmonaut than during the era of the pioneers. Can I agree with that? Hardly. And this is why. The requirements for cosmonaut candidates have not been lightened but, on the contrary, expanded, since the content of the profession has changed. Earlier we devoted an entire year to general space training, but now we are leaning toward the opinion that it is necessary to lengthen this period. The assignments that must be carried out during a flight have also become incredibly more complicated.

Nevertheless, today's cosmonaut is not only an investigator with a broad profile. He is, as before, a pilot and an operator who controls space equipment. This he is taught during the second stage of his training, during spaceflight training. There are no teaching spacecraft as yet. This is the specific nature of our work, and there is no way out of it. After instruction in a trainer, a pilot can fly in a teaching aircraft. Next to him will be an instructor, who points out his errors and prompts him on the best way to do things. A cosmonaut, however, immediately finds himself setting out on a real flight.

Without exaggeration it is possible to say: each spaceflight begins on Earth. First the cosmonauts study theory, plans, mockups and active models of all of the ship's and station's assemblies. Then they move on to lessons in specialized trainers and work out each operation and entire flight stages. Finally they switch to an integrated trainer that makes it possible to simulate an entire flight, from takeoff to landing. The trainers are fitted with computers that model the behavior of onboard systems, depending on the operator's commands. The trainer reacts to the cosmonaut's actions in the same way as a real ship does: the engines are turned on and off, the surrounding situation changes in the portholes. In a word, a complete illusion of movement in space is created.

However, even this trainer does not give the cosmonaut any idea of several physical conditions of spaceflight, such as weightlessness. Flying laboratories acquaint him with the world of weightlessness. When an airplane climbs vertically and then flies along a parabola, the people in it experience weightlessness for 20-25 seconds. That is not very long, of course, but it does enable one to understand what it is like. The Il-76 laboratory airplane is equipped with a system for gathering and recording technical and medical information and has a cabin with a volume of about 400 cubic meters that makes it possible to install training equipment weighing up to 6 tons.

Extended operations in weightlessness are worked out in a special pool known as the hydrolaboratory. By the way, in our pool, which is 23 meters in diameter and 12 meters deep, it is possible to place a "Salyut" station along with a docked transport ship. Cosmonauts in pressure suits, who have zero buoyancy at depths of 3-5 meters, can stay for hours under conditions close to those encountered in space, where there are no reference points.

Centrifuges are used for cosmonaut training, as well as during the preparations for first flights into space. The training program also includes flights in aircraft and parachute jumps. True, there were opponents of the flight training. Even for its proponents, not everything was clear. What types of airplanes should be used? What type of flying should be mastered at each stage? What habits should be inculcated and which ones can be excluded? Substantial research was required before

these questions could be answered. Flights in airplanes and parachute jumps help form professional operating qualities in cosmonauts: rapidity of throught, emotional stability, psychological preparedness to act under complicated flight conditions, the ability to endure the effects of spaceflight factors and so on.

For the study of space navigation, as well as the development of scientific research techniques using heavenly bodies, specialists from the GDR helped us build and put into operation a planetarium. It reproduces about 900 stars and constellations from the sky and the movements of the Sun, the Moon and the planets.

The Center's instructors prepare cosmonauts for any unexpected occurrences. Truly, it only seems that space missions have become a normal thing. For example, could it have been foreseen that during the final stage of their flight, V. Lyakhov and V. Ryumin would have to disconnect the radiotelescope's skeleton antenna from the station? Not hardly.

The methodologists are constantly placing the space investigators in complex, unusual situations during their training. Before going on a flight, a crew deals with hundreds of them. It is only natural that a crew becomes accustomed to acting confidently in unforeseen situations.

But now the complicated flight program, which has already lasted for many months, is completed. The cosmonaut must return to Earth healthy and cheerful. In order to do this, during a flight it is necessary to engage in purposeful physical exercise on a systematic basis. The practical experience gained during six expeditions in the "Salyut-6" and "Salyut-7" orbital stations has shown: if crew members follow the prescribed regime conscientiously, their return to the world of gravity will be easier. It is difficult to force oneself to engage in physical exercise, even if one is fully convinced of the need for it. Imagine yourself, a cosmonaut, without moving forward, turning the pedals of a veloergometer for a long time, until you are sweating bullets. And walking or running on an endless belt, exercising with expanders must be done for 2-2.5 hours every day. This is not so much sport as it is real work. One has to be a very determined person to live under such a strict regime for months. This is why we do not simply give a great deal of attention to physical exercise, but try to prepare a crew psychologically to the rigorous conditions in space.

In short, preparing a crew for a flight has now become both simpler and, at the same time, more difficult. Simpler because we now know quite a bit about space have at our disposal modern equipment and modern training methods. More difficult because space programs have become incomparably more difficult. A crew member must be physically and psychologically prepared to work under unusual conditions, must know his space technology flawlessly, and must be an excellent pilot and a knowledgeable investigator. Such specialists, capable of carrying out critical assignments for the Fatherland, are trained by the Center.

Space research is an organic part of our national economic plans. Going out into near space, cosmonauts know that they have been called upon to work in the name of the Soviet people's and all of mankind's happy future. They are carrying out their labor watch with honor and are showing bravery, endurance and master skills. An example of this is the longest flight yet made, 211 days, by Soviet cosmonauts A. Berezovoy and V. Lebedev. They made a large contribution to the implementation of

the 26th CPSU Congress's decisions on the peaceful conquest of space in the interests of the development of science and the national economy of this country.



11746
CSO: 1866/124

SPACECRAFT SIMULATORS

Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 4, Apr 83 p 3

[Article by I. Pochkayev and V. Grigorenko, candidates of technical sciences: "The Training Base"]

[Text] A scientifically substantiated training system that meets the requirements of today and future problems is now in operation at the Cosmonaut Training Center imeni Yu.A. Gagarin. Its material basis is a training base that is constantly being developed. It now includes integrated and special trainers, stands and simulators for spaceflight conditions.

The integrated trainers for simulating transport ships and orbital stations make it possible to work out all stages of a flight into space in sequence. In connection with this, the following basic operations are gone through most carefully: injection into orbit; orbital flight with orientation of a manned spacecraft (PKA) on the Sun, the Earth, terrestrial orientation points, the stars and the planets; PKA navigation on the basis of objects in space; maneuvering in orbit; finding, approaching and docking with other spacecraft; undocking and descent from orbit.

For the formation of stable habits, of course, hundreds and sometimes even thousands of ground training lessons are necessary. It requires great efforts on the part of both the cosmonauts and the engineering staff participating in the training. Otherwise, the work of many collectives could come to nought.

The formulation of the structure of space training, as was the case with the conquest of space itself, followed an unbeaten path, and each new achievement involved a great deal of work. For example, the first trainer for the "Vostok" ship, which is now exhibited in the Zvezdnyy Gorodok Museum imeni L.I. Brezhnev, was a full-sized teaching and training model.

Later, for the "Voskhod" and "Soyuz" ships, trainers were built that made it possible to work out dynamic operations with the participation of a cosmonaut. According to the devices in them, the trainers of this generation were independent ones.

As a rule, each of them had five independent functional units: a PKA mockup, a computer system, a coupling unit, a visual situation simulator and an instructor's panel. Their basic shortcoming was their rigid, almost unalterable, structure. Therefore, with the introduction of some modifications in the flying models there arose the necessity of revising the trainers.

Now, from today's viewpoint, one can only imagine what organizational and technical difficulties the creators and operators had to overcome when revising the trainers. Actually, almost every PKA--even those in the same series--differed from its predecessors.

The further development of space technology, the complication of the assignments given the crews, and the enlargement of the degree of their participation in space experiments raised the requirements for the trainers substantially. The role of not only the technical, but also the economic and organizational, aspects in their creation increased. Actually, each of them is a unique technical complex of which only one exists.

The search for further ways to develop the structure of space training led to the necessity of creating a trainer complex. This conclusion was reached on the basis of the results of a number of scientific investigations conducted at the Cosmonaut Training Center imeni Yu.A. Gagarin in conjunction with industrial enterprises. The creation of the trainer complex involved the integration of the trainers' basic systems and the imparting to them of the property of flexible, programmable readjustment. The realization of this approach became possible on the basis of the extensive use of modern digital computer technology.

The structural plan of the trainer complex also includes five basic units. In connection with this, each of them--with the exception of the PKA mockup--is a shared-use system. Therefore, only the mockup of the manned spacecraft is individual for each person.

It goes without saying that the number of programmable "assembled" and simultaneously functioning trainers depends on the capabilities of the units in the trainer complex. Its foundation is a computer system created on a base of modern computers. It makes it possible to model the systems of various spacecraft and, at the same time, to reorganize the trainer complex's units to "assemble" specific trainers.

The coupling units are digitial-to-analog, analog-to-digital, or other types of converters. They are used for information or signal matching among all the systems in the trainer complex.

The units for the simulation of the visual situation are more costly, complicated and labor-intensive to produce. Their basic units (modules)--space optical observation facilities--have a narrowly specialized purpose. The use of the modular principle makes it possible to create a unified, flexibly adjustable visual situation system according to a program realized by a digital computer. In the future they will be standardized on the basis of the use of optical television and computer methods for forming visual images.

The situation with the instructors' panels is analogous. Constructed on the basis of graphic displays, they are becoming shared-use facilities, and during training are part of the makeup of any of the "assembled" trainers. This makes it possible to reduce the number of individual instructor's panels.

The changeover to a trainer complex based on the integration of the basic units makes it possible to utilize its resources more fully, reduce the production time for trainers for modified PKA's, and reduce the economic expenditures for the technical facilities for the training of cosmonauts.

11746
CSO: 1866/124

INDIAN COSMONAUTS BEGIN JOINT TRAINING WITH SOVIETS

Moscow IZVESTIYA in Russian 8 Oct 83 p 2

[Article by B. Konovalov, special correspondent of IZVESTIYA, Zvezdnyy Town: "Team in Zvezdnyy: Soviet-Indian Space Crews Start Joint Training"]

[Text] The training for a joint Soviet-Indian spaceflight is entering its final stage. The Indian cosmonauts, together with their Soviet colleagues and instructors have begun joint training as crews.

On 6 October, their exercises turned out to be unusual. Before the training session there was a meeting with Soviet and Indian reporters, who had come to Zvezdnyy to meet the crews.

The director of cosmonaut training, Lt Gen Avn V. Shatalov tells the reporters: "This is not the first time they all met. The Indian cosmonauts have had a year of intensive theoretical training. There were naval exercises; now there are classes in a trainer spacecraft. As always, two international crews are training on an equal footing for a mission. We have tried different combinations of cosmonauts and then, taking into consideration their personal likings, the opinion of metodologists and psychologists, the present crews were definitively formed. The ones who have trained the best will fly in space to work."

Six cosmonauts lined up before us, against the background of the training spacecraft, on which was printed in large white letters "USSR SOYUZ T." Col Yu. Malyshev, commander of the first crew (conditionally for the moment), is standing next to V. Shatalov. Together with V. Aksenov, the former was the first to test the Soyuz T spacecraft in the manned mode in 1980. Malyshev had been the commander of the Soviet-French crew. But then, the physicians unexpectedly discovered that there was something wrong with his heart. Instead of him, V. Dzhanibekov went on the mission with J.-L. Chretien and A. Ivanchenkov. But Malyshev did not lose his courage, trained persistently and now the doctors have deemed him to be in perfect health.

The flight engineer of this crew is N. Rukavishnikov. He is an experienced cosmonaut and has been in space three times already. The last time he was with the Bulgarian cosmonaut, G. Ivanov.

Rakesh Sharma, major in the Indian Air Force, is the crew's research engineer. He was born in 1949 in Patiala. He graduated from school in Hyderabad. He

has been an officer in the Indian Air Force since 1970. Before coming to Zvezdnyy he was a squadron commander. This fighter pilot has logged a total of 1600 hours. He has worked as a test pilot. He is living in Zvezdnyy with his wife and 8-year-old son. His smile, which reveals very white teeth, is charming, and one cannot help wanting to compare it to Gagarin's.

The second crew is headed by our record holder, with respect to time spent in space, A. Berezovoy. Together with V. Lebedev, last year he worked in space for 211 days. And now, not only was he able to rest after such a long-term "space marathon," he has achieved excellent physical conditioning.

The flight engineer, G. Grechko, is also a famous Soviet cosmonaut. We worked for a month aboard Salyut-4 and spent 96 days in space in a second mission with Yu. Romanenko on the Salyut-6 station.

Their colleague, Ravish Malhotra, is a colonel in the Indian Air Force. He is older than his countryman, he was born in Lahore in 1943. He graduated from secondary school in Calcutta. He received his first officer rank 20 years ago. He is a fighter pilot. He worked as a test pilot. He was the commander of an aviation wing, which is a large division of the Indian Air Force. He has logged a total of 3400 hours. Malhotra came to Zvezdnyy with his wife, son and daughter.

"Our crew is unique," said Berezovoy, with a smile, to the reporters. "This is the first time that two cosmonauts with whiskers will work together."

"I also promise to grow a moustache," added Grechko, laughing.

"Then we shall always remain clean-shaven, for the principle of it," says Malyshev, picking up the cue.

One senses from this exchange of jokes that the cosmonauts are in good spirits and there are friendly relations between them.

"At present, we are gradually changing from three separate personalities into a crew that has to work as a single whole," N. Rukavishnikov tells the reporters.

We are very pleased with our Indian colleagues," continues Yu. Malyshev, "they catch on to everything very fast, and one senses in their work the great experience of test pilots. They are both very industrious, work with enormous willingness and try to 'absorb' as much knowledge as they can."

"What are your first impressions of the joint training?" the reporters ask, requesting that the Indian cosmonauts respond in Russian.

"This year, we started with naval training," said R. Sharma. "It was very hard and interesting. The water, rough sea and a real descent vehicle--all this made an enormous impression. For pilots, this is more interesting than theoretical classes. Now we are studying the trainer, and I think that we will be ready for the lift-off."

"We have had a very interesting, intense year of training in Zvezdnyy behind us," continued R. Malhotra. We have learned much, but the main job is ahead of us. We hope to become well-trained with the help of our Soviet colleagues in the months that remain before the flight."

The Indian cosmonauts speak quite decent Russian, although they have an accent. They have made remarkable strides in a year. And they not only learned to comprehend conversational Russian, but also mastered the difficult technical terminology.

The logo for the mission--USSR and Indian flags and above them a ladder carrying the Sun God above the clouds--could be seen on the suits of all six cosmonauts who were introduced to us.

Next year, it is not mythical steeds, but rocket engines with millions of horsepower that will lift the Soviet-Indian crew above the clouds.

10,657
CSO: 1866/23

## COMMENTARY ON 'PROGNOZ-9' SATELLITE

Moscow PRAVDA in Russian 10 Oct 83 p 7

[Article by R. Sagdeyev, academician, USSR Academy of Sciences, N. Kardashev, corresponding member, USSR Academy of Sciences, and I. Strukov, candidate of Physico-Mathematical Sciences: "Probing the 'Depths' of the Universe-'Prognoz-9': Our Commentary"]

[Text] On 1 July 1983, thePrognoz-9 artificial earth satellite was launched in the Soviet Union. For the first time, the main task of space research is to study the structure of the universe as a whole and the main features of its evolution.

Contemporary concepts of the structure of the universe are linked to facts derived from astronomical observations which have received a thorough theoretical grounding. It has now been established that the observed universe is expanding and the speed of recession is seen to increase as more distant galaxies are observed. This fact leads to the fundamental conclusion that, approximately 15 billion years ago, all matter was in an extraordinarily dense state and the bodies known to us (galaxies, stars, planets and even atoms) could not have existed at that time. The matter of the universe was in some other, extraordinary state and the bodies mentioned above could only have been formed through expansion.

Another area of research is concerned with the elucidation of the chemical composition of matter in the universe. The relative abundance of the various elements is under study, not only in terrestrial laboratories and on various bodies of the solar system, but also at vast distances in space as far as the most distant quasars. Out of 1000 atoms, on an average, 900 turn out to be hydrogen, around 99 are helium and only 1 is a heavier element. These quantities of hydrogen and helium were obtained as a result of nuclear reactions which occurred at the initial stage of the expansion of the universe at very high temperatures.

The hot universe model involves a high density of electromagnetic radiation for that period and there must have been around 100 million photons for every baryon (proton or neutron) of matter. This ratio practically does not change during the later expansion of the universe during which there is a constant fall in temperature. After approximately one million years from the start of expansion, the temperature has fallen to 4,000 degrees and the photons no longer ionize matter which thus becomes neutral.

As the universe expands further, the radiation "decouples" from matter and becomes increasingly long-wave. In our epoch, the so-called "relict" radiation reaches the earth in the form of radio waves arriving from all points on the celestial sphere. Now, after 15 billion years, the temperature of the universe has fallen to 3 degrees from absolute zero. The most recent research results make it possible to begin to study the over-all structure of the universe since it is attaining its greatest size. Experiments have been begun on "Prognoz-9" in order to produce a complete brightness map of the sky in the millimeter range where relict radiation is most intense.

What kind of basic questions are linked to the distribution of radio emission intensity? One of the most important questions of contemporary science concerns the beginning of the expansion of the universe. Theoretical physics and astrophysics predicted that at the first moments of expansion there would be violent and almost fantastic processes in the superdense and superheated matter and a swiftly varying gravitation field. These processes include variations in vacuum characteristics and in the space-time structure and lead to the present state of the universe.

How can there be experimental research on the initial period of the history of the universe? It is possible only by studying the "traces" left by these violent processes. One of these traces is the distribution in space of the brightness of the relict radiation. Investigation of this so-called radiation anisotropy is the most important task in the new trend in cosmic research. The map of the heavens makes it possible to answer questions such as, are there regions of space-time which have had an evolution different from that observed in the parts of the universe known to us ("other" universes)? Is the universe expanding in the same way now as in the past in all directions, or are there differences? What are the greatest dimensions and masses of objects in the universe and how and when did the process of formation of stars and galaxies begin?

With the help of the radiation map of the heavens in the millimeter range it will be possible to arrive at solutions of other important astronomical questions as well. These include determining the distribution, in our galaxy, of regions of hot plasma, of electrons with superhigh energies and of interstellar dust. There could also be detection of shells of hot plasma around the nearest galaxies and clusters, clouds of intergalactic gas and radiation from distant and very large clusters of galaxies which are in the formation stage.

The main technical problem here is the creation of a radiotelescope with extremely high sensitivity. In order to carry out the first experiment on-board the "Prognoz-9" satellite, a small radiotelescope was installed which operates on the 8 millimeter wave. In order to eliminate the thermal effect and radio interference from the directions of the earth and sun, the satellite was, for the first time, placed in an extremely elongated orbit with a perigee at around 1,000 and apogee at around 700,000 km. The period of revolution of the satellite is around one month. In addition, the satellite revolves around an axis directed towards the sun with a period of 2 minutes.

The radiotelescope is equipped with two antennae with an especially low level of lateral radiation. One of them is a horn antenna oriented along the axis of rotation of the satellite which receives radiation from the side opposite to the sun. The other horn-parabolic antenna rotates with the satellite and picks up radiation perpendicular to the axis of rotation.

The antennae are switched in turn to a measurement device and once per second the intensity of the radio emissions is measured for a region of the universe with an angular dimension of 5 degrees. During one rotation of the satellite around its axis, 72 such sections are measured in a ring in the celestial sphere. Radiomapping of a single such ring takes a week. After this, the satellite axis is tilted 7 degrees and the next ring of the celestial sphere is radiomapped. A radiomap of the entire celestial sphere can be made in six months.

The heart of the device is the highly sensitive parametric amplifier operating with a unique semiconductor pump oscillator. Sensitivity is also provided by enormous temporary storage capacity for radiosignals since the radiotelescope and all onboard systems, including that for stellar orientation, have to operate continuously for many months.

The basic component units of the radiotelescope were made at the Academy of Sciences USSR Space Research Institute in close association with collectives from several industrial organisations. The participants in the experiments express their sincere gratitude to all organisations and especially to the collectives of the Ministry of the Electronics Industry for their essential aid without which it would have been impossible to build such sensitive apparatus.

A large volume of data has been collected and processes during two months of flight. The expected high-grade parameters of the "relict" radiotelescope were completely confirmed. Measurements of radio emission intensity were carried out for 30 percent of the celestial sphere. At the same time, preparation for the next stage has been started and the sensitivity of the device has already been significantly improved. And it may be possible to glimpse "other", previously unknown, universes.

12497
CSO: 1866/19

UDC 62.50

STRUCTURE OF PHASE SPACE AND BIFURCATIONS IN EQUATION FOR MOVEMENTS OF MAGNETIZED SATELLITE IN A PLANAR CIRCULAR POLAR ORBIT

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 21, No 4, Jul-Aug 83 (manuscript received 12 Oct 81) pp 522-535

BATALOVA, Z. S. and MEL'NICHENKO, N. A.

[Abstract] Results are presented from a numeric study of the global structure of phase space equations obtained on the basis of the method of point transformations and the theory of bifurcations in dynamic systems, based on the work of Neymark, Butenin and Fufayev. The study, dealing with the movements of a magnetized satellite in planar circular polar orbit, is reduced to a consideration of point transformation for the surface of a circular cylinder. The main structural element is a unique cell-type non-linear harmonic oscillator, with the cells coupled through the trough points in a closed loop covering either the cylinder or fixed center points. All the synchronisms in the loop are of the same average type. A detailed mathematical description is given of the loop structure. The data on the structure of the phase space equation establish a picture of the mutual positions of synchronisms of various types, making it possible to use computing facilities to determine synchronisms of practical interest. Figures 9; references 12 (Russian).
[184-9642]

UDC 550.37

EQUILIBRIUM FUNCTION OF PITCH AND ANGLE DISTRIBUTION OF ENERGETIC PARTICLES IN NONADIABATIC SCATTERING ON CURRENT SHEATH OF MAGNETOTAIL

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 21, No 4, Jul-Aug 83 (manuscript received 5 Jun 81) pp 557-561

TSYGANENKO, N. A.

[Abstract] A study is made of the question of pitch-and-angle distribution of energetic particles in the current sheath of the night sector

magnetotail using numeric methods, and a calculation is made of the equilibrium function for distribution by pitch angles. The scatter matrix and its connection with the steady-state pitch angle distribution for particles are examined and a method is shown for calculating the steady-state distribution function. A calculation model is proposed for analysis. Calculations of the scatter matrix and distribution function are made. Results are discussed within the context of using them in a concrete model of a magnetic field for studying the effectiveness of ionospheric filling in the magnetotail. Figures 2; references 5: 3 Russian, 2 Western.
[184-9642]

UDC 551.535

FEATURES OF ENERGY STATUS OF PLASMASPHERE IN ZONE OF MAGNETOSPHERIC CONVECTION

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 21, No 4, Jul-Aug 83 (manuscript received 19 Oct 81) pp 562-568

KOYEN, M. A., KHAZANOV, G. V. and KHAZANOV, D. V.

[Abstract] An attempt is made to find an analytical solution for plasma temperatures in the plane of the geomagnetic equator taking into account longitudinal plasma movement and the effect of bulk magnetospheric convection during plasmospheric heating and cooling. Formulas are shown for energy shift and balance, ignoring particle sources and energy sink. A method for calculating a heat source is examined and plasma density is considered. It is shown that in the evening sector, plasma temperature reaches steady-state level and does not depend on the parameters of bulk convection. In the early morning, temperature increases in line with the increase in the L-shell number. References 18: 13 Russian, 5 Western.
[184-9642]

UDC 533.951.2

OBSERVATIONS OF SIGNAL FROM SOVIET MIDDLE-LATITUDE VLF EMITTER IN MAGNETOSPHERIC ZONE OF UPPER IONOSPHERE

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 21, No 4, Jul-Aug 83 (manuscript received 29 Jun 81) pp 569-573

LARKINA, V. I., MOLCHANOV, O. A. and MAL'TSEVA, O. A.

[Abstract] Results are presented from an experiment to record VLF waves passing along a trajectory through the magnetosphere. The experiment was conducted 20 February through 5 March 1980 using a transmitter (L = 2.6,

f = 15 kilohertz) aboard the "Intercosmos-19" satellite in an attempt to clarify the nature of VLF propagation in the magnetosphere. The equipment used was the ANCh-2ME VLF receiver developed at Institute of Terrestrial Magnetism, Ionosphere and Radiowave Propagation, enabling simultaneous recording of electric and magnetic signal components within the frequency range 0.07 to 20.0 kilohertz. Details of the receiver are given. The VLF emitter transmitted amplitude-modulated 2-second pulses at 2-second intervals or 8-second pulses at 8-second intervals. Of 12 experimental sessions, only four produced results suitable for analysis. Observation results are presented in tabular form showing main propagation characteristics. Analysis of results showed that the zone in which the signal was received in the magnetoadjacent field was centered mainly on the L-parameter and the emitter meridian, with slight variations, and that signal entered the magnetoadjacent zone at phi angles (angle between wave normal and direction of geomagnetic field) far from resonance angles. Results showed that signal amplification of the order 10-15 dB occurred in the magnetosphere, and possible mechanisms involved are discussed. Figures 2; references 14: 7 Russian, 7 Western.
[184-9642]

UDC 581.521

## DAYTIME HIGH-LATITUDE PROFILE OF SOLAR COSMIC RAY PROTONS AT Ep $\gtrsim$ 1 MeV

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 21, No 4, Jul-Aug 83 (manuscript received 10 Sep 82) pp 577-583

IVANOVA, T. A., SOSNOVETS, E. N. and TVERSKAYA, L. V.

[Abstract] The structure of daytime high-latitude protons streams from solar cosmic rays at Ep $\gtrsim$ 1 MeV and the relationship of the proton streams in the auroral zone and in interplanetary space was studied in conditions of moderate and strong magnetic perturbation during the period of two solar flares occurring 18 April 1972 and 3 April 1979. Data on the 1972 flare were obtained from the "Cosmos-480" satellite, and on the 1979 flare from the "Cosmos-900" and "Cosmos-1067." The events were accompanied by marked north-to-south asymmetry in proton intensity above the polar caps. Details of satellite orbits during data acquisition are given. Analysis of results showed that penetration of proton streams at the energies studied into the auroral zone took place via the plasma layer of the magnetotail and through the daytime boundary close to the neutral points. These zones were accessible from all directions. Mixing and leveling of the proton streams took place as the result of rapid magnetic drift in the neutral layer and the outer fields of the daytime magnetosphere. In the presence of anisotropic interplanetary flow at the same polar latitudes at which maximum intensity was recorded, a projection was formed at the boundary of the closed and open force lines on both sides of the proton streams. In moderate magnetic perturbation in the daytime high-latitude auroral zone, proton streams were isotropic within 2-5° of the closed zone boundary; in strong magnetic

perturbation, proton streams were isotropic for the entire auroral zone. Figures 3; references 13: 6 Russian, 7 Western.
[184-9642]

UDC 550.385.41

STUDIES OF MID-LATITUDE IONOSPHERIC TROUGH USING GROUND-BASED GEOPHYSICAL METHODS AND SYNCHRONOUS MEASUREMENTS WITH SATELLITES

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 21, No 4, Jul-Aug 83 (manuscript received 23 Sep 82) pp 584-608

SIVTSEVA, L. D., FILIPPOV, V. M., KHALIPOV, V. L., GAL'PERIN, Yu. I., YERSHOVA, V. A., NIKOLAYENKO, L. M., PONOMAREV, Yu. N. and SINITSYN, V. M.

[Abstract] After extensively reviewing earlier work, initiated by Muldrew (1965), on the mid-latitude ionospheric trough, the authors present supplemental data to their own earlier work on the diffuse auroral zone and review new experiments using satellite and ground measurements to identify the polar boundary of the trough and clarify the main processes in the subauroral F-region leading to the formation of the polar walls of the trough. The authors' results are based on data obtained from the "Aureole-1" and "Aureole-2" satellites in 1971-1974 and simultaneous vertical and inclined upper-air observations, and spectrophotometric measurements made in Yakutiya. Work on the main ionospheric trough and the diffuse precipitation boundary conducted within the framework of the Franco-Soviet "ARKAD-2" project using the "Aureole-2" satellite is described with particular reference to the night subauroral F-region. The role and place of radiation at 6,300Å in stable auroral red arcs is discussed using experimental data. Data are presented on plasma convection in the night subauroral F-region and discussed in the light of earlier work. Experimental results indicate that in prolonged perturbation the position of the polar walls of the trough in the night sector coincides with ionospheric projection of the plasmapause and that the main trough lies within the plasmosphere. Figures 10; references 104: 33 Russian, 71 Western.
[184-9642]

UDC 581.521

SPATIAL, SPECTRAL AND ANGULAR STRUCTURE OF ELECTRON FLUXES AT ENERGIES OF 30-120 keV AT LOW HEIGHTS DURING MAGNETICALLY QUIET PERIODS

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 21 , No 4, Jul-Aug 83 (manuscript received 24 Jun 82) pp 609-618

GORYAINOV, M. F., DRONOV, A. V., DOVTYUKH, A. S. and SOSNOVETS, E. N.

[Abstract] Using data obtained from the "Cosmos-900" satellite a study was made of differential spectrums and the spatial structure of electron fluxes at energies of 30-210 keV in the night and morning sectors during a magnetically quiet period occurring 13 April 1977. Details of the experimental procedure are given and results are presented and discussed. The main conclusions of the experiment are as follows: at the electron energies studied a maximum was found at 50-80 keV at a height of approximately 500 km, formed mainly under the effect of pitch-angle diffusion at the outer edge of the magnetosphere. Anisotropic flow from particle energy plays a role in differences found in the spatiotemporal and spectral structure of electron fluxes. Electron fluxes with energies up to about 100 keV are virtually anisotropic, while fluxes at energies greater than 130 keV are usually not anisotropic. The South Atlantic and Brazilian magnetic anomalies affect electron flux intensity in the middle latitudes; details are given. Figures 4; references 14: 3 Russian, 11 Western.
[184-9642]

UDC 629.78.015.076.6: 521.4

ON ONE CLASS OF INTERMEDIATE ORBITS

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 21, No 4, Jul-Aug 83 (manuscript received 18 Jan 83) pp 634-638

LUKASHEVICH, Ye. L.

[Abstract] The movement of a satellite in a model gravitational field is considered mathematically. Gravitational field potential permits solutions to the problem in closed form as $V = W + \Delta V_{2n}$ ($n = 2, 3, 4, \ldots$) where W is the force of a symmetrical variant in a generalized problem for two stationary centers, and $\Delta V_{2n}$ is an expression that approximates the even zonal order 2n harmonic $\Delta U_{2n}$ from the aggregate of terms for the actual gravitational potential ignored in W. A class of intermediate orbits is found that takes strict mathematical account of all perturbations from the second zonal harmonic and also secular and partial periodic second order perturbations. The results can be generalized for building an intermediate orbit, taking into account any given number of even zonal harmonics. References 2 (Russian).
[184-9642]

UDC 531.01: 629.78

FLIGHT TRAJECTORIES WITH MAXIMUM TANGENTIAL THRUST IN CENTRAL NEWTONIAN FIELD

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 21, No 4, Jul-Aug 83 (manuscript received 8 Feb 82) pp 638-642

AZIZOV, A. G. and KORSHUNOVA, N. A.

[Abstract] The plane problem of determining optimal trajectories for points moving with a limited per second expenditure of mass in a central newtonian force field is treated mathematically. It is shown that trajectory points will be spiral curves, indicating that the segments found with maximum tangential thrust can be used to solve acceleration problems dealt with elsewhere by Beletskiy and Yegorov and by Okhotsimskiy. The problem is worked numerically by way of illustration. Figures 2; references 3 (Russian).
[184-9642]

UDC 65.012.2: 629.198.3

USE OF GRAPHIC ANALYTICAL METHODS TO SOLVE PROBLEMS OF CURRENT PLANNING FOR SCIENTIFIC EXPERIMENTS

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 21, No 4, Jul-Aug 83 (manuscript received 16 Dec 81) pp 642-644

BELYAYEV, M. Yu. and TYAN, T. N.

[Abstract] The use of graphic analytical methods in current planning for scientific experiments is considered, using as an example the case of the movement of a space vehicle used in an experiment and plotted with the aid of a special noninertial coordinate system. The position of a rotating oxyz coordinate system relative to an absolute OXYZ system is shown graphically and the practical use of such a system is considered when nomograms are used to find the parameters determining the position on a plane orbit in space. Graphic difficulties in constructing orbit circumferences are resolved. Figures 2; references 3 (Russian).
[184-9642]

METHOD FOR ALTERNATE INTEGRATION AND INTERPOLATION AND ITS USE IN DETERMINATION AND PREDICTION OF SPACE VEHICLE ORBITS

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 21, No 4, Jul-Aug 83 (manuscript received 10 May 82) pp 644-647

YASTREBOV, V. D. and YEGOROV, I. D.

[Abstract] A numerical analytical method for rapid determination and prediction of orbits for space vehicles is proposed. The method is based on the numerical solutions for equations in finite differences suggested elsewhere by Taratynova (1960) and enables calculation of orbital parameters for ascending nodes. Alternate integration and interpolation of orbital parameters should be slowly changing functions of the number of orbital revolutions for the entire period of prediction. An algorithm is derived to find the coefficient of the polynomial and is used to consider to variants in the problem of determining the orbit of a space vehicle. In variant I the orbit is determined by processing measurements directly and in variant II the orbit is determined from "generalized" measurements made over short time intervals. Results are shown from ballistic navigational problems for a series of satellites moving in orbits at heights of the order of 500-900 km and at inclinations varying between 50° and 80°. Practical recommendations are offered on application of the proposed method. References 6 (Russian).
[184-9642]

METHOD FOR CALCULATING RADIOBRIGHTNESS TEMPERATURE IN SATELLITE METEOROLOGY PROBLEMS

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 21, No 4, Jul-Aug 83 (manuscript received 2 Jun 81) pp 647-650

KACHURIN, L. G.

[Abstract] The problem of determining atmospheric radiation shift as applied to satellite meteorology is treated mathematically in the context of radiobrightness temperature for layers of the atmosphere. It is shown that one essential condition for using the Rayleigh-Jeans equation for shift from atmospheric radiation to radiation temperature is constancy of properties in the medium. This condition is usually not met in the atmosphere or in the range of high radio transmissivity, and this can lead to significant error in solving problems in satellite meteorology, primarily when determining the vertical temperature profile from radio emission.
References 3 (Russian).
[184-9642]

UDC 581.521:

MEASUREMENT OF HIGH ENERGY ELECTRONS IN RADIATION BELT BY 'BOLGARIYA-1300' ARTIFICIAL EARTH SATELLITE

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 21, No 4, Jul-Aug 83 (manuscript received 10 Jan 83) pp 651-652

GAL'PER, A. M., GRACHEV, V. M., DMITRENKO, V. V., KIRILLOV-UGRYUMOV, V. G., POLUKHINA, N, G. and ULIN, S. Ye.

[Abstract] Results are presented from measurements of electrons at energies greater than 30 MeV made by the "Bolgariya-1300" satellite (period of orbital revolution 102 minutes, inclination 81°, apogee 900 km, perigee 800 km). The measurements were made in order to clarify the nature of the Brazilian anomaly, studied earlier by using the "Salyut-6-"Soyuz"-"Progress" complex. A special instrument designated "Elektron," employing Cerenkov gas detectors and scintillation counters, was developed to measure electrons at energies greater than 30 MeV and protons at energies greater than 100 MeV. The "Elektron" is mounted on the "Bolgariya-1300" in such a way that its axis is permanently oriented perpendicular to the orbital plane, enabling measurement of particles with pitch angles of 75° to 115°. Measurement results are shown from a 30-orbit run above the Brazilian anomaly. Some 20-30% of the radiation belt is composed of electrons. Electron fluxes at energies of 30-500 MeV in the peripheral field of the Brazilian anomaly are at least an order of magnitude greater than at the equator. High energy electron fluxes in the radiation belt increase by two orders of magnitude from heights of 300 km to 900 km. It is concluded that electrons are a significant component in the high-energy charged particles in the Earth's radiation belt. Figures 1; references 4 (Russian).
[184-9642]

UDC 524.1-732

PROSPECTS IN STUDIES OF GAMMA BURST SOURCES

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 21, No 4, Jul-Aug 83 (manuscript received 5 Jul 82) pp 653-655

MERSOV, G. A. and ESTULIN, I. V. (deceased)

[Abstract] Results are summed up from experiments conducted in 1977-1980 by the Soviet "Prognoz-6" and "Prognoz-7" and the "Venera-11" and "Venera-12" space vehicles and the "Vela," "Helios-2" and Pioneer Venus Orbiter to investigate gamma bursts and their sources. The results suggest that it is necessary to improve the sensitivity and accuracy of experiments in order to identify gamma bursts with greater reliability. In order to collect sufficient data it will be necessary to record at least $10^3$ localized bursts at energies of the order of $10^{-5}$ to $10^{-4}$ erg/cm$^2$. This may

be done by increasing the detector cross section from the order of 100 $cm^2$ to $10^3$ $cm^2$, enabling detection of bursts at energies of the order of $10^{-8}$ $erg/cm^2$. The question of placing Earth satellites in suitable orbits to study gamma bursts is considered. Schemes are presented for placing a series of three satellites in elliptical, synchronized orbits around the Earth and in heliocentric orbits in order to insure optimal spatial configuration to conduct experiments to detect gamma bursts. Similar configurations of satellites could also be used to determine the coordinates of solar gamma activity. Figures 2; references 7: 4 Russian, 3 Western.
[184-9642]

UDC 523.7

AUTOMATIC OBSERVATIONS OF SUN WITH INSTITUTE OF PHYSICS IMENI LEBEDEV RT-22

Moscow TRUDY ORDENA LENINA FIZICHESKOGO INSTITUTA IMENI P. N. LEBDEVA: EVM I KAMAK V NAUCHNYKH ISSLEDOVANIYAKH in Russian No 147, 1983 pp 95-101

APUSHKINSKIY, G. P., LOSOVSKIY, B. Ya. and TOPCHILO, N. A.

[Abstract] The operation of the RT-22 radiotelescope for automatic solar observations at the radioastronomy station at the USSR Academy of Sciences Institute of Physics imeni P. N. Lebedev is described. The system used with the RT-22 comprises two M-6000 computers operating in parallel; system hardware is described and the rationale of the configuration explained. System requirements for automatic solar observations are discussed using a block diagram of the system. Work is done in two modes, namely tracking a single solar source for a given period of time, and scanning a given sector of the Sun; operation in these two modes is described in detail. The features of tracking an active field of the Sun are explained for quiet phase tracking and tracking during solar flares, using earlier observations as examples. The scanning of active fields during solar flares is discussed. Use of the system enables rapid mapping of both the entire Sun and parts of it, scanning across the solar radius and between two random points, and circular scanning across the entire disk or part of the disk. Figures 7; references 5: 4 Russian, 1 Western.
[168-9642]

UDC 629.197

## INVESTIGATION OF MOON'S GRAVITATIONAL FIELD FROM TRAJECTORY MEASUREMENT DATA ON SOVIET ARTIFICIAL LUNAR SATELLITES

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 21, No 4, Jul-Aug 83 (manuscript received 15 Sep 82) pp 499-511

AKIM, E. L. and VLASOVA, Z. P.

[Abstract] Results are presented from a global study of the lunar gravitational field reflecting large-scale deviations from the central field. Models used in the study are constructed from trajectory data on Soviet lunar orbiters. A description is provided of the system of corrdinates used to plot trajectory movements. Data were obtained from orbiters of the "Luna" series, with "Luna-19" and "Luna-22" providing the greatest amount of data. Measurements used in the study were obtained during the period 1966-1976. Determination of parameters for noncentrality in the lunar gravitational field is described. Models of the lunar gravitational field are built on the basis of statistical processing of trajectory data. Additional data on the movement of U.S. lunar orbiters are incorporated in the model using results from determination of the lunar gravitational field rather than the primary data, which are unavailable to Soviet researchers. Discrepancies between measured and calculated values for the lunar velocities of orbiters are attributed to the inadequacy of the models. Further studies of the lunar gravitational field are anticipated, with attempts to include local structures and small-scale field fluctuations in the model. References 7: 6 Russian, 1 Western. [184-9642]

UDC 629.785: 523.42

FEATURES OF PHYSICAL MODELING OF TOUCHDOWN OF DESCENT APPARATUSES OF 'VENERA-9'--'VENERA-14' AUTOMATIC INTERPLANETARY STATIONS

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 21, No 4, Jul-Aug 83 (manuscript received 12 Oct 82) pp 536-539

GRIGOR'YEV, Ye. I. and YERMAKOV, S. N.

[Abstract] In an attempt to improve existing physical models, criteria are established for dynamic similitude in the touchdown process for "Venera"-type descent apparatuses. Criteria are based on the following parameters: mass of the descent apparatus, its central transverse moment of inertia, the position of the center of mass on the vertical axis, horizontal and vertical touchdown velocities, initial angular position of the descent apparatus in the plane of touchdown, initial angular velocity relative to center of mass, the base of the descent apparatus and its recoil diagram, recoil elastic rebound, the coefficient of friction and slide on the planet's surface, planetary rate of gravity, and angle of slope on the landing surface. The criteria lead to certain changes in the characteristics of the touchdown process, which are explained. Calculated and experimental data confirm the soundness of the criteria for touchdown parameters, which can be used for physical modeling of the process. Figures 2; references 6: 4 Russian, 2 Western.
[184-8642]

UDC 629.785: 523.42

MATHEMATICAL MODELING AND EXPERIMENTAL STUDIES OF TOUCHDOWN OF 'VENERA-9'--'VENERA-14' INTERPLANETARY STATIONS ON DEFORMABLE GROUND

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 21, No 4, Jul-Aug 83 (manuscript received 12 Oct 82) pp 540-544

BUSLAYEV, S. P., STULOV, V. A. and GRIGOR'YEV, Ye. I.

[Abstract] A mathematical model is shown for the touchdown process of the "Venera"-type descent apparatuses on the Venusian surface, making the assumptions that the strength of the surface is less than that of the toroidal shock-absorbing ring on the descent apparatus and that the penetration of the descent apparatus into the ground is of a complex nature. The latter implies that the mathematical model should be generally applicable for different physical models of ground deformation and should describe the complex shape of the lower part of the descent apparatus. A physical model was built and used to test mathematical models of the touchdown on deformable ground. Calculated and experimental data are compared with each other and with data available on the touchdowns of "Venera-9"--"Venera-14." It is found that for "Venera-13" and "Venera-14" no significant ground

deformation occurred, which may indicate that the toroidal shock-absorbing ring was deformed. Accordingly, the proposed mathematical model is not fully applicable to all the "Venera" stations. However, the method can be used to determine the physical-mechanical properties of the ground at landing sites on deformable surfaces of celestial bodies when for any reason no optical data are transmitted from an automatic station. Figures 4; references 8: 5 Russian, 3 Western.
[184-9642]

UDC 523.035: 523.42

SCATTER OF RESONANCE LINES IN UPPER VENUSIAN ATMOSPHERE FROM ULTRAVIOLET MEASUREMENTS MADE BY 'VENERA-11' AND 'VENERA-12' AUTOMATIC INTERPLANETARY STATIONS

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 21, No 4, Jul-Aug 83 (manuscript received 2 Mar 83) pp 545-556

KURT, V. G., SMIRNOV, A. S., TITARCHUK, L. G., BERTAUX, J-L. and LEPIN, V. M.

[Abstract] A theory is developed for calculating the intensity of radiation in the upper Venusian atmosphere as a function of the angle of incidence for solar radiation and the angle of observation. The method is based on an analysis of data obtained with ultraviolet spectrometers mounted on the "Venera-11" and "Venera-14" stations during their December 1978 flypast of Venus. Details of the geometry of the observations are shown. Two methods are used to match the theoretical model with observed data, namely an approximation solution to the shift equation and modeling the shift process in the resonance lines using the Monte Carlo method. The calculation method is described and used to calculate line intensity for HeI lambda 584 angstrom. Results are compared with actual observation data and show satisfactory agreement. Analytical formulas are shown for intensity of radiation for the case where optical thickness for scatter is low and absorption is occurring in a continuous spectrum. Figures 6; references 7: 2 Russian, 5 Western.
[184-9642]

UDC 537.591

EVALUATION OF HEIGHT OF ACCELERATION FIELD FOR CHARGED PARTICLES IN SUN

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 21, No 4, Jul-Aug 83 (manuscript received 27 Oct 82) pp 574-576

DAYBOG, Ye. I., KURT, VIKTORIYA G., STOLPOVSKIY, V. G.

[Abstract] It is shown that data on the form for the spectrum of low-energy protons and electrons in solar flares can be used to evaluate the density of material in the acceleration field or the amount of material in particles moving from the field of generation to an observation point in the interplanetary medium. Because of loss caused by collisions, at the point of observation a maximum should be formed in the particle spectrum whose position is determined by the length of the route or the amount of material in a particle; an expression is shown for this maximum. Adiabatic cooling during propagation in the interplanetary medium also leads to energy loss; the magnitude of this loss is calculated. Calculated results for density are compared with observation data. A model distribution for density is built using data obtained from the "Venera" vehicles in 1979 and 1981. The model shows that acceleration processes for charged particles and subsequent energy losses occur within the range of densities $10^9$ to $5 \cdot 10^{11}$ $cm^{-3}$. Figures 3; references 14: 4 Russian, 10 Western.
[184-9642]

UDC 535.36: 523.42

ELECTRICAL ACTIVITY IN ATMOSPHERE OF VENUS, PART 2: MEASUREMENTS ON VENUS SATELLITES

Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 21, No 4, Jul-Aug 83 (manuscript received 27 Oct 82) pp 619-633

KSANFOMALITI, L. V.

[Abstract] Measurements of electrical activity in the Venusian atmosphere as recorded in the Pioneer Venus Orbiter Electric Field Detector (OEFD) experiment and by "Venera"-type probes are analyzed in great detail with copious references to published work on the subject. Measurements are discussed within the context of statistical connections between discharges and elements of the relief, the search for light flashes, discrepancies between optical and electromagnetic measurements, the sources of discharges, and unexplained phenomena in the lower layers of the Venusian atmosphere. It is concluded that the numerous electrical discharges on Venus come from sources at rates up to 20 per second per source; that whistler propagation of low-frequency components occurs on the night side; that electron concentration is low up to heights of 115 km; that sources of electromagnetic radiation can be considerably lower than the cloud layer; that refraction enables

propagation of radiowaves over distances of 3,000 km and more; that the question of optical radiation in discharges remains unclear; that the total number of sources could be quite small; and that the electromagnetic pulses associated with electrical discharges may be close to the sites of volcanic activity. Figures 6; references 41: 11 Russian, 30 Western. [184-9642]

UDC 521.2

THEORY OF MOTION OF HALLEY'S COMET

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 272, No 5, Oct 83 (manuscript received 3 Jun 83) pp 1091-1096

AKIM, E. L., SAVCHENKO, V. V. and STEPAN'YANTS, V. A., Institute of Applied Mathematics imeni M. V. Keldysh, USSR Academy of Sciences, Moscow

[Abstract] Plans call for sending space probes to intercept and study Halley's comet. Solution of the difficult navigational problems involved requires more precise determination of the comet's coordinates at the time of rendezvous by three orders of magnitude in comparison with present-day accuracy. This dictates careful investigation of the dynamics of cometary motion on the basis of observations of its most recent appearances. Accordingly, the authors have formulated a theory of motion of this comet on the basis of optical angular observations made in 1910, 1835, 1759 and 1682. The theory is intended for prediction of cometary motion. It can serve as a basis for ballistic-navigational computations needed in preparing flight of a probe to the comet and computation of highly accurate ephemerides. A mathematical model of cometary motion was developed. For example, the heliocentric coordinates of the comet were computed by numerical integration of a system of ordinary differential equations of its perturbed motion in the central gravitational field of the sun. It is assumed that perturbing acceleration is symmetric relative to cometary orbit perihelion: $F_i = A_i g(r)$, $i = 1, 2, 3$, where $F_i$ are the components of the perturbing acceleration $\bar{F}$ along the radius-vector, transversal and binormal, $A_i$ are numerical coefficients. Accuracy of the theory was increased by introduction of relativistic corrections to the classical Newtonian theory of motion of celestial bodies. Among the subjects considered are: computation of heliocentric coordinates of planets perturbing cometary motion, methodological errors in computing motion of the comet and planets, collection and reductions of observations and analysis of these observations. Accuracy evaluations indicate that determination of the comet's coordinates at pericenter 1986 is possible with an accuracy to several thousand kilometers. Such a determination requires use of observations in August-December 1985 and observational data for 1910 and 1835; the $A_1$ and $A_2$ coefficients must also be determined. Figures 1; tables 3; references 7: 1 Russian, 6 Western. [22-5303]

## BIOMEDICAL EXPERIMENTS ON SOVIET-FRENCH FLIGHT

Moscow ZEMLYA I VSELENNAYA in Russian No 2, Mar-Apr 83 pp 18-22

[Article by Ye.I. Vorob'yev, USSR deputy minister of health and corresponding member of the USSR Academy of Medical Sciences, and A.R. Krotovskaya, doctor of medical sciences: "Medical-Biological Research"]

[Text] Soviet-French space cooperation is being conducted in accordance with an intergovernmental agreement signed in Moscow in 1966. This cooperation has meant a large number of experiments dealing with virtually all fields of space research. The parties responsible for the cooperaton are the National Space Research Center (CNES) for France and the "Interkosmos" Council for the USSR.

Working groups have been organized in accordance with the main directions of scientific research (space physics, space communications, meteorology, and space biology and medicine). The first joint biological experiment, the "Tsitos" experiment, was conducted in real spaceflight conditions on the manned "Salyut-6" station. Its purpose was to study the effect of spaceflight factorsp primarily weightlessness, on the growth and development of very simple biological objects.

The "Bioblok-2" radiobiological experiment on the Soviet "Kosmos-936" artificial Earth satellite was conducted in order to gain an understanding of the effect of cosmic radiation on biological objects. It was preceded by extensive ground radiobiological studies in charged particle accelerators.

### Program Development

In connection with the high-level agreement (April 1979) that a French cosmonaut should participate in a flight to the Soviet "Salyut" space station, in October 1979 the first expanded meeting of Soviet and French specialists took place in Moscow to discuss questions connected with cosmonaut selection and training and the scientific program for the mission.

In December 1979 the discussion of questions concerning the upcoming flight by the Soviet-French crew continued in Moscow. It was then, proceeding from their scientific significance, the feasibility of conducting them, and the priority and proposed periods of the flight by the French cosmonaut, that two

categories of experiments were singled out. In terms of readiness, the first was practically feasible but required essential scientific and technical work; and in the end the second group included experiments that should be resolved within the framework of long-term cooperation. The technical incorporation of these experiments and also the requirements for equipment, technical documentation and so forth were discussed during the course of 1980. During the conference of Soviet-French working groups in Baku in late 1980 the program for medical-biological experiments was finally settled. It included two medical experiments--the "Ekhografiya" and "Poza"--the "Tsitos-2" biological experiment, and the Bioblok-3" radiobiological experiment.

Medical problems in space flights are extremely varied, but there are two specific problems in cosmonautics, namely living in weightless conditions and the effect of radiation. These very two problems in all their aspects have been and are being investigated now as limiting factors for the length of time that man can remain in space and as determining the selection of the trajectories for space flights.

It can now considered established that from the physiological standpoint weightlessness is not simply a reduction in the forces that constantly act on the human body but an active factor that causes a reaction in the physiological systems of the body and requires definite adaptation. The initial period in space is the most difficult for man (3 to 5 days). During this time the cosmonaut has the feeling of blood rushing to his head, his nose is blocked, the face swells and the head aches. These symptoms are often accompanied by dizziness, loss of appetite and nausea and sometimes emesis and illusions about the position of the body. Weightlessness causes changes in blood circulation associated with the redistribution of the mass of circulating blood into the upper half of the body. This in turn can increase the flow of blood to the heart and the linear and volumetric circulation of blood in the vital organs and tissues and become the cause of lowered work capacity. Even though the effect of weightlessness on the cardiovascular system has been studied for a long time, many questions have been inadequately investigated. This is associated largely with the fact that until recently indirect calculation methods were usually used during flight and the information received from them and their accuracy were limited.

"Ekhografiya"

In order to evaluate the functional status of the cardiovascular system in man in weightless conditions and to clarify the mechanisms causing impairments it is necessary to use more up-to-date methods that have been proven in clinical practice and that provide an objective quantitative evaluation. Such methods are available; they include ultrasound echocardiography and Doppler readings of the vessels. Using these methods it is possible to make both quantitative and qualitative evaluations of changes in the main indices characterizing the pumping and contractile function of the heart and also linear and volumetric blood flow in major arteries and veins. Using these methods at rest and during functional testing makes it possible to obtain new data. This was the purpose of the "Ekhografiya" medical experiment, which was conducted using a set of equipment known as the "Ekhograf," developed by French scientists. The equipment

consists of an electronics unit, a videotape recorder, a television screen, and a set of sensors and other equipment (ultrasound probes, electrodes for recording the EKG, headphones, power cable, tape cassettes and so forth).

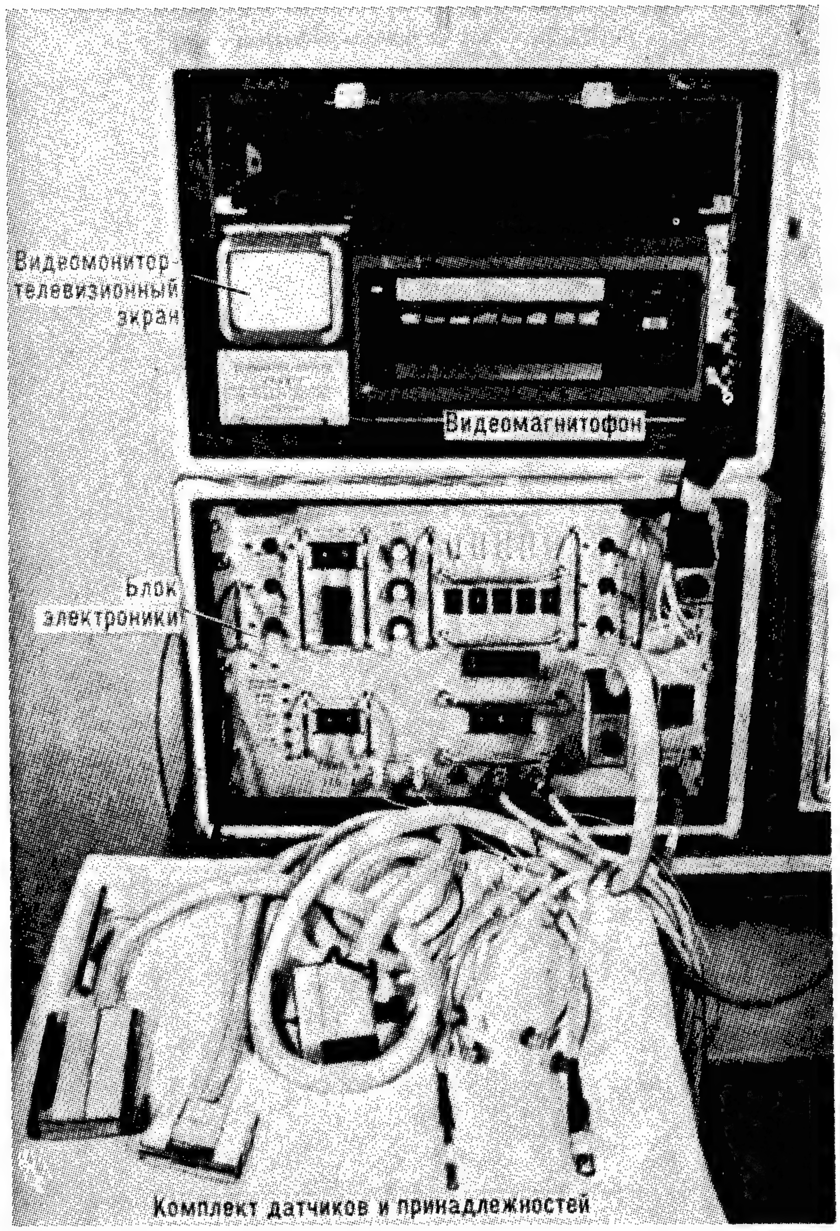



Figure 1. The "Ekhograf" Equipment for Stduies of the Cardiovascular System.
Video monitor TV screen
Video recorder
Electronics unit
Set of sensors and equipment

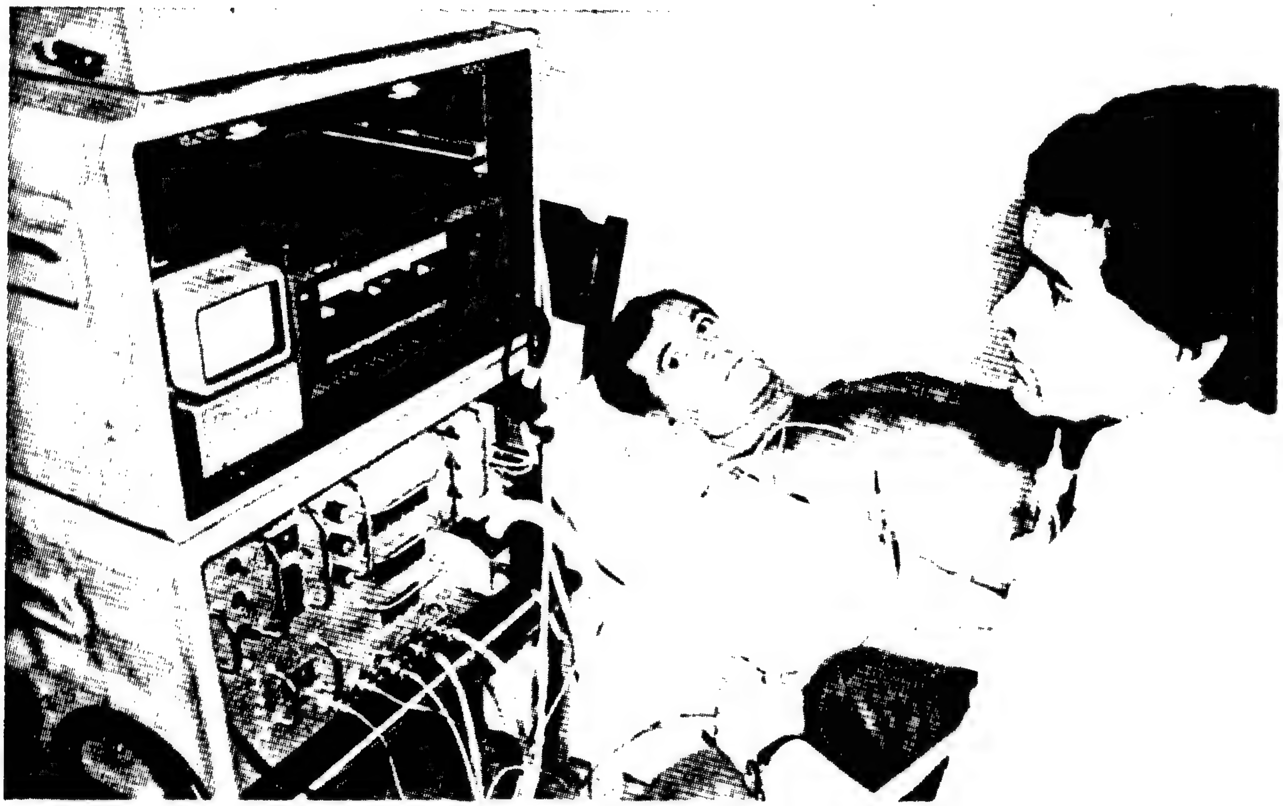


Figure 2. Cardiovascular Studies in the French Cosmonaut Jean-Louis Chretien Using the "Ekhograf" Equipment.

The French cosmonaut Jean-Louis Chretien found the necessary vessel (the aorta, veins and arteries and specific parts of the heart) in himself, using various probes [zondy]. He tried to get on the television screen an image close to the model in the flight log he received on Earth before the flight. In addition, the special headset enabled him to find the required artery or vein from its characteristic sound. For example, when the probe was on the common carotid artery the typical "arterial" sound resembling the sharp, short cracks of a whip was heard in the headset. If the probe was on the jugular vein, he heard a steady soft noise similar to that of surf. Work with this apparatus required a great deal of time, attention and patience. The study included first the "Krovotok" experiment--visualization of the vessels and measurement of the linear and volumetric rate of blood circulation in the body's major arteries and veins--and second the "Ekhografiya" experiment--measurement of the volumes of the heart chambers and the dynamic indices characterizing myocardial pumping

and contractile function. Data obtained were recorded on a videotape recorder mounted in the "Ekhograf." The cassettes with the magnetic recording were returned to Earth with the crew after completion of the joint mission and are now being processed and analyzed.

As a result of this experiment the scientists hope to obtain new information on the dynamics of cardiac volumes and the distribution of blood between the major vessels of the head and the legs during the most difficult period of adaptation to weightlessness, and then develop and propose means and methods that will facilitate the process of adaptation to weightlessness in cosmonauts in future flights.

"Poza"

The second medical experiment was the "Poza." All natural motor skills in man are developed in normal terrestrial gravitation. Therefore, the normal complex of sensory signals in whatever form carry information reflecting the body's interaction with the gravitational field. In weightless conditions the muscular, tactile and sensory systems probably provide information that is different from that given in terrestrial conditions. The visual reflection of the body's position relative to surrounding objects is less altered. As a result, a mismatch occurs between the sensory systems, and this is one of the reasons for the impairment of movement coordination.

The aim of the "Poza" experiment was also to study changes in sensorimotor reactions, occurring in weightlessness, that insure coordination of muscular activity and posture during voluntary movement, and also to assess the process of adaptation in this system to weightless conditions; and to investigate the role of the sight, in particular the peripheral vision, or total "shutdown" of sight, in controlling movement in these conditions. In order to set up the experiment, the onboard "Poza" equipment was fabricated in France. It consists of a platform on which the cosmonaut stood with his feet tethered, an electronics unit and a preamplifier unit carried on the cosmonaut's back, together with a set of sensors and electrodes. Recordings were made of electrical activity in four muscles in the right leg and of accelerated arm movements when it was lifted, using an accelerometer, along with changes in the slope of the ankle joint when the moving part of the platform was shifted. All signals were converted to digital form and recorded on an onboard magnetic recorder.

During the course of the experiment, when given a sound signal the cosmonaut raised his extended right arm sharply, trying to point it toward a target set at eye level; or he rose rapidly to his feet and maintained that position. Using special eyeglasses, an inflight evaluation was made of the role of vision in maintaining a posture. The eyeglasses afforded normal vision or could be used to cut out the peripheral vision, that is, only a small area in the central field of vision remained visible. And finally, by closing a blind it was possible to comletely "shutdown" the vision.


Figure 3. Jean-Louis Chretien During Studies in the "Poza" Experiment

Special eyeglasses
Accelerometer
Platform

"Tsitos-2"

The "Tsitos-2" experiment can be assigned to the class of biological tests. Its aim was to study resistance to antibiotics in certain representatives of microflora in man.

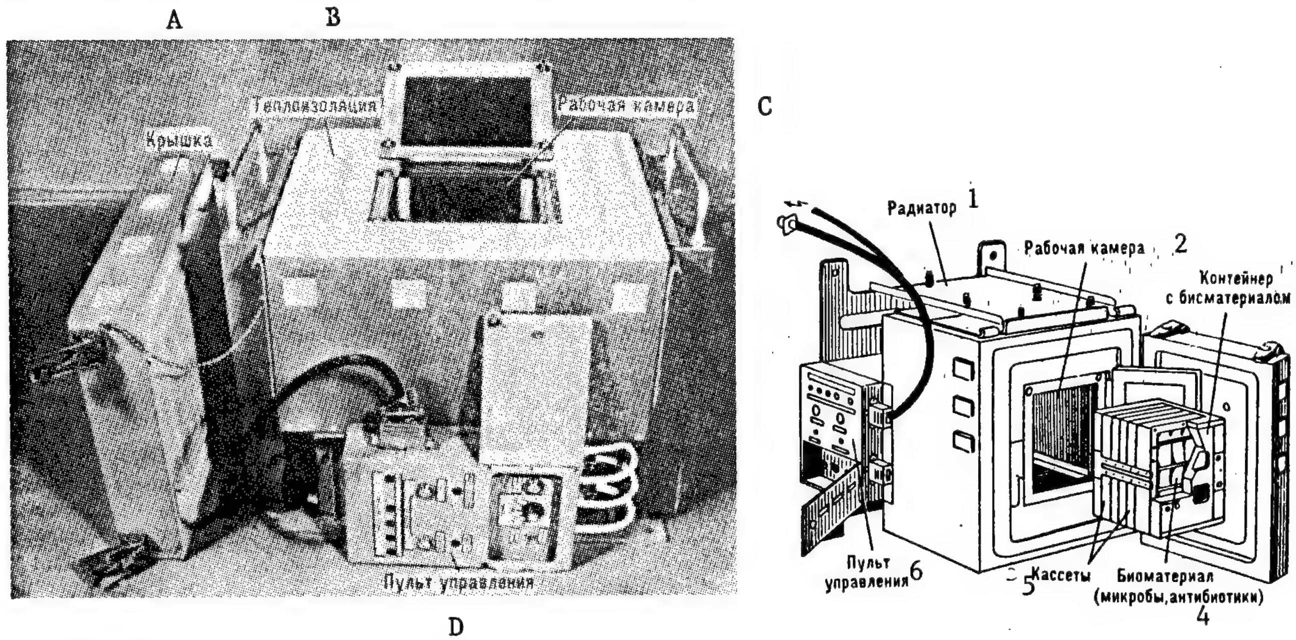



Figure 4. Photograph and Layout of the "Tsitos-2" Instrument.

Key:

| | | | |
|---|---|---|---|
| A. | Cover | C. | Working chamber |
| B. | Thermal insulator | D. | Control panel |
| 1. | Radiator | 4. | Biological material (microbes, antibiotics) |
| 2. | Working chamber | 5. | Cassettes |
| 3. | Container with biological material | 6. | Control panel |

Strains of staphylococcus and E. coli were selected for the main experimental cultures. A triple microbiological investigation of the cosmonauts was carried out. Studies were made of the staphylococcal medium in the airways and the gut microflora. An evaluation was made of the microorganisms' biological activity and also their sensitivity to the antibiotics that were used during flight while conducting the "Tsitos-2" experiment. All the microflora isolated from the cosmonauts before the flight were sensitive to antibiotics, which was in accord with the experimental requirements. In setting up the experiment the premise was that the status of biological subjects--the microorganisms--might be altered in weightlessness while the status of the antibiotics remained

unchanged. Before the flight the microorganisms and the antibiotics were kept isolated in separate containers. During flight, man "helped" to bring the staphylococci and E. coli together with the corresponding antibiotics at various concentrations. The "Tsitos-2" experiment pursued the practical goal of providing recommendations on which antibiotics to include in the onboard medicine chest.

"Bioblok-3"

The "Bioblok-3" experiment was in fact a continuation of the "Bioblok" radiobiological series of experiments conducted earlier with French scientists. It was an attempt to investigate the biological effect of cosmic rays.

One specific factor in space flight is the effect of heavy charged particles. It is of special significance in long-duration space flights. In order to make a reliable evaluation of the danger from heavy charged particles and to make predictions about radiation damage in space flights of varying duration it is essential to comprehensively study the features in the action of these particles on various biological systems. To this end, on Earth model radiobiological studies are being conducted in charged particle accelerators, together with investigations aboard the "Cosmos" series of biosatellites and the "Salyut" manned station.

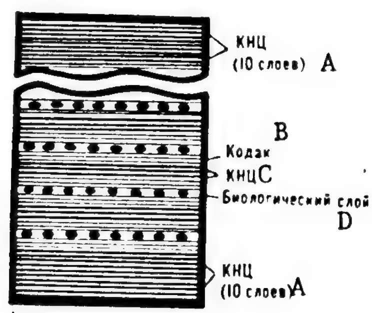



Figure 5. Scheme for Arrangement of Plastic Physical Detectors (KNTs, [expansion unknown], Kodak), and Biological Layers with Seeds.

Key: A. KNTs (10 layers  C. KNTs
B. Kodak  D. Biological layer

Findings from studies show that the consequence of effects from heavy charged particles on biological objects is structural damage in these objects (Protoza, seeds and so forth).

However, because of the low intensity of streams of cosmic rays and the relatively short duration of flights exposing biological objects, up to now few data have been gathered. Accordingly a series of radiobiological experiments in space lasting from several months to a year is in order. The "Bioblok-3" experiment was one of the experiments in this series. The "Bioblok" is a set of biological objects and detectors that are arranged in the form of a "layer cake." The "bioblok" weighs 4.5±0.2 kg. One layer weighs 0.75 kg. The

biological objects selected included lettuce seeds (USSR) and tobacco and rice seeds and cysts of Artemisia [Artemiya salina] (France). Nuclear photemulsions and thermoluminescent and track detectors were used for recordings.

An arrangement of six units (three Soviet and three French) was set up aboard the "Salyut-7" station. They were secured to the station walls at specific places using special "fasteners" that enabled individual units to be removed from the arrangement and returned to Earth. Provision was made for several periods of exposure (1.5-2 months, 6-8 months, and 10-12 months). One period was completed by the end of the Soviet-French mission. While preparing for the return to Earth Jean-Louis Chretien took Soviet and French units from the station wall, and brought them back to Earth in the vehicle. The Soviet unit is remaining in the Soviet Union for further work while the French unit was dispatched to France. After the results have been processed data will be obtained on the charge and energy spectrums of cosmic rays within the charge range of 6 to 26 units at energies up to 500 MeV/nucleon, together with information on survivability in biological objects, damage to the hereditary structure when acted upon by charged particles, and, finally, various kinds of material at the cellular and organism level.

Two Soviet-French crews were trained at the Cosmonaut Training Center imeni Yu.A. Gagarin for the scientific research program, and one of them successfully completed the program (ZEMLYA I VSELENNAYA No 5, 1982, p 2, p 3 of cover--ed). The scientific material is now being processed and analyzed and will then be presented first in the form of a single scientific report agreed by scientists from both countries, and finally as individual articles and reports in the press,



9642
CSO: 1866/115

DEVELOPMENT OF SPACE BOTANY EXPERIMENTS

Moscow TEKHNIKA-MOLODEZHI in Russian No 4, Apr 83 pp 2-7

[Article by Aleksandr Mashinskiy and Galina Nechitaylo: "The Birth of Plant Growing in Space"]

[Text] Early last December we--two specialists in biological experiments in space--prepared to fly to Dzhezkazgan along with members of the search and recovery service.

We were to meet cosmonauts Anatoliy Berezovoy and Valentin Lebedev who had been working in space for a record 211 days.

After the disturbances connected with the repeated delay in the takeoff because of the whim's of the Moscow weather, when we were finally airborne we started to be tormented by doubts. Would we succeed? would our group be the one working at the rendezvous? It all depended on from which of several possible landing orbits the descent of the space vehicle started. If for any reason flight control delayed the reentry, then one of the other backup groups would do the work. But we very much wanted to do it ourselves.

Virtually all the crews are very interested in biological experiments. This is also noticeable at the study sessions at the training center, and at the Baykonur cosmodrome when space apparatuses are being loaded before the launch and during the flights. At flight control center it has become customary for the crew to talk with a biologist and discuss the course of a given experiment and refine the method, and to talk together about the results: the cosmonauts to tell what happens on the orbital station and we about how control is effected in the laboratory.

We find our own group at the hotel. Its leader was very concerned. The landing was to be special, at night. This rarely happens. And the weather was still bad. Literally 10 minutes before takeoff to the landing site the fog suddenly closed in. One after another the helicopters arrived at their appointed places. And although it was our group that was included for work, we were hampered in going out to meet the cosmonauts at the landing site by a recent fall of soft snow. The helicopter blades threw up such a cloud of snow that it was even impossible to see the ground as soon as the helicopter was airborne. We had to go out to a reserve airfield and pin our hopes on

the knowledgeable specialists from the search and recovery group. If they could insure normal conditions for the cosmonauts, then they could do the same for the biological subjects. And in fact, the next day we received our material in perfect condition.

How It All Started.

Even K.E. Tsiolkovskoy pointed out the need to use higher plants as a means of providing air and food for people on prolonged flights beyond the Earth. It is in the work of this genius of a scientist that we find the first "technical conditions" for setting up space greenhouses and habitations on orbital installations with closed ecological systems. And as long ago as 1915-1917 F.A. Tsander started to set up experiments in his Moscow apartment to create, as he put it, lightweight greenhouses for aviation.

What had been dreamed about theoretically began to be implemented in real life under the leadership of S.P. Korolev. Experiments on the effect of spaceflight factors on plants started in 1960 on the second space vehicle/satellite. At that time, Tradescantia, Chlorella, and the seeds of various varieties of onion, pea, wheat and corn made the flight and for the first time were returned successfully to Earth. Chlorella cultures also flew in space on the manned "Vostok-5" vehicle. Since then, plant organisms have journeyed into space on all our space vehicles, orbital stations and the "Cosmos" series biosatellites.

In 1962 the chief designer outlined an entire program of botanical and agrotechnical research in space. He wrote: "Work on 'Tsiolkovskiy' greenhouses must be initiated, with gradual buildup of the elements or units; and work must be started on 'space harvests.' What is the makeup of these sowings, which plants are to be used? What is their effectivess? their usefulness? What is the convertibility (repetition) of sowing plants from their own seeds in a long-duration greenhouse? Which decorative plants requiring minimum expenditure and care is it possible to have aboard a station in the greenhouse? How will this work be organized: along which lines of plant growing (and questions of soil, moisture and so forth)?; will the lines be mechanized or 'solar heat and light'?; what equipment and systems will be used to regulate the greenhouse?; and so on." (This fragment was published with other writings by Korolev in TEKHNIKA-MOLODEZHI No 4, 1981, pp 30-31).

On the initiative of the chief designer, the "Bios" experimental closed biotechnical complex was soon set up in Krasnoyarsk. The researchers maintained oxygen, plant nutrients and water for long periods using life-support systems involving higher plants and algae.

People in an Artificial Environment.

The "Bios" complex consisted of four sealed compartments, one of which was used by the crew; two others contained hydroponics installations [fitotrony], while the fourth held the containers for the algae [kul'tivatory]. The entire complex was enclosed in a sealed steel housing in the shape of a right-angled parallelepiped 15 meters long and 2.5 meters high, enclosing a volume of 315 cubic meters.

The crew compartment contained three cabins, a kitchen-dining room, a shower with toilet, a laboratory and workshop and a rest area.

Each hydroponic installation contained metal trays with a combined total area of 17 square meters for growing wheat, and a vegetable area of 3.5 square meters for vegetables in which beet, carrots, fennel, turnip, leaf cabbage, white radish, leak, cucumber and sorrel were grown on keramzit [a lightweight concrete aggregate--ed] glass. The three Chlorella containers occupied 30 square meters.

Theoretically there was no doubt: man could live normally in this kind of artificial environment. However, the life-support systems had to be checked during the course of a ground experiment and then developed for space vehicles.

The "Bios" became the arena for several successful manned experiments. The longest lasted 180 days. And it was possible to achieve a close biotechnical system at the level of 82-95 percent in terms of atmosphere and water. When they attempted to go beyond this limit the researchers encountered a quite interesting problem.

If it exceeds a certain number of organisms by a certain minimum, a community of organisms becomes a self-restoring system. To use the technical language, living organisms within a biotechnical system are not only maintenance-suitable but also maintenance-capable. But the technical assemblies cannot restore themselves when they have reached the end of their service life; they must be maintained. It is necessary to move up to a new level for complete harmony of the equipment to a time when self-restoring machines appear.

What Is Geotropism?

Because of the exceptional complexity and perfection of his body, man adapts very rapidly and differently to new conditions. It is very difficult to know his specific response to a given factor. And, moreover, with people in space we still do not have the facilities for setting up a large enough number of parallel experiments differing by just one factor. A much simpler model is needed for this. This is where plants have come to our aid; working with them is sometimes much more convenient than, for example, small laboratory animals.

During the process of evolution many animals have developed mechanisms that are responsible for perceiving the force of gravity. The properties of plants in response to this force are called geotropism.

Charles Darwin linked the turning of plants which occurs under the effect of gravity with the presence of substances moving in the growth zones. Later, D. Sachs formulated the concept of geotropic response, seen in the form of processes that occur in sequence. And later, two directions were noted in this research. The first was associated with the names of (Nemets) and (Gaberlandt), who created the so-called statolithic theory. According to this theory, the geotropic response occurs because of the pressure of the moving grains of the amyloplast-statolith on the protoplasm. The other

hypothesis, put forward by (Kholodnyy), proceeded from the difference in the physico-chemical properties of the root and stalk protoplasms, as a result of which electrical polarization of the cells occurs. Went supplemented this suggestion, proposing that growth movements are based on polarized shifts in special substances--the auxins.

Scientists conducted the first experiments to study the geotropic response in centrifuges receiving their motion from a mill wheel. An acceleration of 3.5g was achieved in this way. At an acceleration of 1g the roots and stalks of kidney beans accurately bent along the direction of the vector of gravitational and centrifugal forces, now in equilibrium. This was a direct proof that it is the force of gravity that determines the direction of growth. But only practical cosmonautics provided an opportunity for checking this.

Hopes and Disappointments.

In 1971 the "Vazon" installation with two tulips was sent beyond the Earth aboard the "Soyuz-10." Unfortunately, however, the docking with the "Salyut" station did not take place, and only the specialists in the recovery group ever observed the opened flowers on Earth.

The quite advanced "Oazis," equipped with telemetry and movie-film recording systems, was used on the "Salyut-4" orbital station. The studies were done with peas.

"At first," cosmonaut Georgiy Grechko relates, "things did not go well. The water did not reach the places it was supposed to, and then it started to pour in large drops and we had to run about wiping it up with napkins; then we had to run about finding napkins. But on the whole the experiment was successful and we obtained mature, 23-day-old plants. True, there were no flowers, but it was possible to record the dynamics of plant growth using time-lapse film."

Grechko himself was one of the first to testify to the psychological support that the cosmonauts derived from plants. He himself, particularly near the end of the flight, would go to the greenhouse on any suitable excuse to have another look at his green friends. Sometimes he found himself doing this unconsciously.

An analyis conducted on Earth showed that despite the external similarity with the controls, the plants differed in terms of cell structure, biochemical makeup and growth characteristics. This, it seemed, confirmed the skepticism of those scientists who even before then had doubted the possibility of normal growth for plants under weightless conditions. Further experiments in plant growing during long-duration space missions brought no consolation either. It was impossible to obtain flowers, let alone seeds, from wheat and peas. At the stage of flower formation the plants simply died. And this fact gave grounds for talking about the basic impossibility of plant growth and development under spaceflight conditions. And it was then that experienced scientific collectives led by academician N.P. Dubinin, academician of the Lithuanian Academy of Sciences, A.I. Merkis, and academician of the Ukrainian Academy of Sciences K.M. Sytnik became involved in solving the problem.

First of all they decided to clarify whether it was weightlessness itself that was causing the effect, or other factors, for example, the cultivation technique. And indeed this technology for such unusual conditions was itself being created. And weightlessness itself was exerting an obvious effect on it. For in the absence of gravity, water and gas exchange in plants takes place differently, and the problem arises of removing metabolites and insuring the necessary heat conditions, since natural convection is also absent. New attempts were made to cultivate plants in conditions in which almost the entire reserve of substances essential for development was concentrated.

In the summer and fall of 1978 during the flight by V. Kovalenok and A. Ivanchenkov, onions were grown using two methods: scientifically, and "like they do in the village of Belaya" where the vehicle commander came from. When the cosmonauts returned to the station after engaging in extravehicular activity, the hint was prudently given: "Well, we worked well. Perhaps now as a reward we could eat one of the onions." But it was still too early to gather the harvest.

"The onions are growing in two containers, one using your method, and the other using mine, the peasant method," V. Kovalenok reported. "If the tops are not pinched off they begin to rot, and but if they are cut off they grow well and do not rot."

"Well, all right. If you want to, you can eat a few shoots."

"We have already. We have eaten 6 out of 14."

And in the television coverage, the commander joked: "The agricultural technique works better; we have proved this with socialist competition. Our onions are growing faster than the scientific onions!" But alas! neither method succeeded in making the obstinate plant flower.

The following year, tulips were prepared at USSR Academy of Sciences Main Botanical Garden in an installation called "Lyutik" for forcing aboard the "Salyut-6" station. The flowers had only to come out in space, but this they "did not want to do." Why? It has still not been possible to find out. At the same time a similar installation was at the North Pole. And when a ski expedition led by I. Shparo arrived there the tulips gladdened the courageous travellers with the bright flame of their flowers.

Operation "Orchid"

But still, making plants flower in space was extremely alluring. Specialists from the Ukrainian Academy of Sciences Central Republic Botanical Garden got involved in the work. They selected epiphytic tropical orchids, many of which are extremely ornamental. The botanists believed that the epiphytic way of life of the orchids, that is, one which does not take place in the soil, should weaken the geotropic effect since the anchoring of their roots in cracks in the ground and in hollows and the forks of branches results primarily from the availability of nutrients in the water. The orchid roots are capable of growing sideways and even upward in search of a suitable substrate.

These plants have a record duration of flowering, up to 6 months. Taking these factors into consideration eight species of orchids were selected.

This time, it seemed, nothing had been left to chance. They designed, built and tested the "Malakhit-2" system--a plant assembly with two lamps and four panels for the plants. The panels were supplied with an artificial ion exchange soil which had been developed for experiments in the "Bios" complex and was later used in the "Oazis" and "Vazon" installations.

Both the cosmonauts, V. Ryumin and L. Popov, had already worked with the "Malakhit" aboard the "Salyut-6" orbital station. Some of the orchids sent there had already flowered. The flowers fell off almost immediately but the plants themselves grew, forming not only new leaves but also air roots. Even without flowers they pleased the cosmonauts with their greenery. The one thing that was recognized--that the plants were growing there with them just as on Earth--gladdened the cosmonauts, which they frequently mentioned in their reports from orbit.

On 30 July 1980, in a television session V. Ryumin said: "We have a system with plants, the 'Malakhit.' And to greet our friend Pham Tuan from Vietnam, we have even grown a flower." And he showed this flower.

What this started! They immediately reported to Kiev, where they identified the species and started to wait with impatience for the flower to return to Earth. And return it did. In one of the panels, there among the leaves was a beautiful white-and-rose flower... It had been artifically made by the cosmonauts from paper.

Operation "Orchid" taught us a lot. Although the exotic plants did not flower in space, in contrast to their doubles on Earth, which throughout the entire course of the experiment in the control "Malakhit" had been almost completely covered with bright flowers, they lasted for almost half a year aboard the "Salyut-6." But once they were returned to the greenhouse in their own botanical garden in Kiev they were immediately again covered with flowers.

And the cosmonauts' trick again showed, on the one hand, how great their desire is to see aboard the station flowering, and, this means, completely satisfactory, plants in the conditions created; and on the other, it once again cautioned us against seeing the desired, and even the visible, for what has actually been achieved.

But why would the plants not flower? In order to answer this question, many experiments have been conducted during the latest expeditions to the "Salyut-6" and the "Salyut-7," using an entire set of original devices for growing the plants.

The Search Leads to Success.

It was essential to help the plants deal with weightlessness. First of all an attempt was made in the "Oazis" to use stimulation from an electric field.

Here, we proceeded from the premise that the geotropic response is associated with the bioelectric polarity of the tissues caused by the Earth's electromagnetic field.

In space experiments this proposal was only partially confirmed.

Studies were also being conducted along other avenues. For example, the shoots of some plants grew in the small "Biogravistat" centrifuge. It created aboard the vehicle a constant acceleration of 1g. It turned out that in the physiological sense, centrifugal forces were adequate gravitational forces. Within the centrifuge the shoots oriented precisely about the vector of the centrifugal force. In a stationary unit, on the contrary, complete disorientation of the shoots was observed.

And in the "Magnitogravistat" device the orienting effect of another factor was studied, namely an irregular magnetic field. Its effect on the shoots of Crepis, flax and pine also compensated for the absence of a gravitational field.

In short, the stubbornness of the researchers was to be envied.

Finally, success came. And it came with the plain little plant arabidopsis. Since it has a cycle of 30 days it grows beautifully in artifical soils. During the last expedition to the "Salyut-6" arabidopsis flowered in the chamber of the "Svetoblok" installation.

Aboard the "Salyut-7" station where A. Berezovoy and V. Lebedev were working, the experiment to grow arabidopsis was prepared with special care. They had the "Fiton-3" sealed chamber with five trays and its own light source. The trays contained a substrate of agar with 98 percent water. As the plants grew they could move away from the light source. The cosmonauts themselves planted the seeds with the aid of a seed drill. At first the plants grew slowly. But on 2 August 1982, V. Lebedev reported:

"Many, many buds have appeared."

And on 19 August, up in orbit they had another interest:

"Can arabidopsis have pods?"

"Of course."

"What color?"

"Green at first, then darkening to a light brown color."

"Then we can congratulate ourselves on our success. There are seven ripe pods and many ripening. A real success!"

When Svetlana Savitskaya visited the station the cosmonauts presented her with a small bouquet of arabidopsis flowers. She carefully drew it. The

picture shows 7 flowering plants up to 10 centimeters high, with 27 pods. On Earth they counted 200 seeds in the pods.

This experiment refuted the opinion that it was impossible for plants to go through all stages of their development, from seed to seed, under weightless conditions.

True, arabidopsis is self-pollinating and is pollinated even before the buds open. Nevertheless, it was a great success. And it was success not only for the scientific collective at the Lithuanian Academy of Sciences Institute of Botany led by A.I. Merkis, but also for cosmonauts Anatoliy Berezovoy and Valentin Lebedev. It can now be said that space plant growing has really been born, and its propsects can be assessed.

Toward the Extraterrestrial Greenhouse of the Future.

"Let us fantasize," we suggested to Valentin Lebedev on his return from the 211-day mission. "Is a greenhouse needed in a long-duration flight?"

"Yes, without doubt. By caring for the plants and maintaining and somehow improving your botanical installations we understood that without plants long-duration space missions are impossible. Before our return to Earth it was simply sad to dig up the plants. We took them out very carefully so that not a single rootlet would be damaged."

"At last you have had enough time to discuss not only the results of the program of new experiments but also the most varied kinds of projects for the space greenhouses of the future."

"These kinds of greenhouses," the cosmonaut thinks, "will take up entire compartments in extraterrestrial stations, for plants need a different atmosphere from people, one with a high content of carbon dioxide and water vapor. The optimal temperature for obtaining the best harvest will also probably be different, and also the length of the light day. But the main thing is that they must have real sunlight. [no closing quotes--ed]

It is not yet technically possible to make very large portholes or entire walls of glass. Evidently, along with a certain increase in the size of portholes, mirror concentrators will have to be used. The stream of light collected by them and directed into the compartment can be passed through a system of waveguides to the plants in the same way that they are supplied with moisture and nutrients. And then Tsiolkovskiy' prediction will come true: that when selecting the plants with the best yields and the optimal conditions for their development, each square meter of the extraterrestrial plantation will be able to fully nourish one inhabitant in the space settlement.

We are all confident that this will be the case!



9642
CSO: 1866/143

## SPACECRAFT COMMAND-MEASUREMENT COMPLEX

Moscow ZEMLYA I VSELENNAYA in Russian No 2, Mar-Apr 83 pp 46-52

[Article by G.M. Tamkovich, candidate of technical sciences: "As Old as the Space Age"]

[Text] With the launch of the first artificial Earth satellite was born a service without which progress in space research is inconceivable. This is the command-measurement complex.

It was on that memorable and joyful day of 4 October 1957 that the wonder-struck people of Earth first heard radio signals from an artificial body that had become a satellite of our planet. But first these signals were received by the command-measurement complex.

At that time, in 1957, even for the specialists the operation of the command-measurement complex with the first artificial Earth satellites was a new and amazing business. No analogues had ever existed. During the development of the new complex to monitor and control artificial Earth satellites a number of important features had to be taken into account, particularly the virtually unlimited (in the future) range, exceptional accuracy and the immediate nature of processing measurement results making it possible to predict movement parameters over significant intervals of time. For in order to make a decision when controlling a space vehicle on its next orbit it is necessary to process all previous information, analyze it, and prepare the possible versions of the decision. Of course, the colossal volume of processed data and the speed needed for this was oriented on the use of computers.

Whereas the development of the first models of space rocket technology had been preceded by tens of years by the work of K.E. Tsiolkovskiy, Yu.V. Kondratyuk, F.A. Tsander and others who laid the foundations of modern cosmonautics, the main principles for the construction and composition of the command-measurement complex were worked out by a group of Soviet scientists only in the mid-Fifties. At the first stage they tried (and not without success) to modernize and adapt some of the radiotechnical facilities used earlier as site measurement complexes. But it became obvious that there was a need to develop basically new facilities for monitoring and control.

The project for the command-measurement complex proposed its development in the shortest possible time. Command-measurement systems were developed taking into account available portable radiotechnical facilities: station equipment used on vehicles or vehicle trailers. Even today it is not easy to grasp that on the entire territory of the Soviet Union, sometimes in unbelievably difficult climatic and natural conditions, far from populated points and often in uninhabited areas, the ground measurement points were created in a very short time. Within half a year from the launch of the first artificial Earth satellite the work had been completed. While automatic and comprehensive testing went on and equipment was being installed, personnel were preparing for direct operations with an artificial Earth satellite.

Veterans of the complex recall the exceptional enthusiasm, feeling of inspiration and unprecedented animation among those developing the command-measurement complex and will always be proud of its selfless workers and heroes. When in the area of one of the points in Siberia a spring flood covered the building and water reached as high as the middle of the windows, and it was possible to move about the territory only in boats, special equipment was moved onto the roof and preparations for operations continued. The communications session took place successfully. At one of the measurement points in a severe winter (immediately before a control session) the air intake of the diesel generator cooling system suddenly got choked up. The operator took off his clothes and in 50 degrees of frost lowered himself into the water reservoir and corrected the fault. The control session took place without incident.

During the launches of the first artificial Earth satellites the relatively simple tasks of the command-measurement complex were the result of the simplicity of the satellites themselves. These tasks consisted mainly of pursuing a single goal--to know how the satellite was moving and "how it felt." But it was still not possible actively to influence the flight from Earth.

At the second stage, when the processes of control had been quite well mastered and they were learning how to "influence" the flight of a space object, the command-measurement complex started to provide backup not only for flying test models of space equipment but also its operation in orbital flight.

Today's command-measurement complex is a complicated, multifunctional, technically unique, automated control complex for controlling all the Soviet space apparatuses, vehicles and stations in active existence in space.

The first artificial Earth satellite, the first flight to the Moon and the transmission of photographs showing its dark side, the first Moon satellite and the lunokhods, the flights to Mars and Venus, the soft landing on the Moon, the delivery of Moon rock, man's first space flight and extravehicular activity, the world's first manned orbital station and orbital scientific research complex, and the realization of international space research programs are all tasks that have been solved with the aid of the command-measurement complex.

Whatever the task to be resolved, it is impossible to get by without controlling the movement of the space apparatus (or vehicle) and the operation of the onboard equipment. This means that it is necessary to measure the parameters of the

space object's motion (range, velocity, angle) within a specified time, process the measurement results in computers using specialy developed algorithms and programs that determine orbital parameters and predict motion, determine the deviation of motion parameters from the calculated parameters and (if necessary) correct the motion, and maneuver and recover the apparatus. The complex for these tasks makes up the ballistics service for the flight of a space apparatus. Objective information on the status of various onboard systems, the operation of automatic devices, temperature and pressure in the orbital compartment of a vehicle and much else can be obtained after telemetry data have been automatically processed. Each second the results of hundreds of thousands of measurements are being "hurled down" to Earth. All telemetry data is passed into the automatic processing circuits and from it each specialist evaluates the operation of his "own" system.

Programs also exist for analyzing the status of onboard systems. Here the evaluation is done not by a person but by a computer. An integral result is shown on a display unit, for example, "heat regulation system--normal." If required it is possible to "call up" more detailed information on the operation of all devices. The use of high-speed computers has made it possible to obtain processed telemetry data almost on a real-time basis. True, this affects only the flow of information transmitted to the control center. The entire volume of telemetry data (complete flow) is processed in another mode. These tasks are resolved with the aid of the telemetry service.

As a rule the combined command-program control method is now used to control space apparatuses (complexes or vehicles); here part of the control function is carried out by onboard automatic devices (including onboard digital computers), while the other part is effected by sending commands from the ground or by transmitting special programs to the spacecraft.

At the testing stage, all work done by the onboard automatic devices is monitored by the "Earth" and in some cases it is necessary to duplicate the work of the command-measurement complex. Thus, the command-measurement complex carries out the functions of measurement, monitoring and control.

Measurement points in the command-measurement complex are located one relative to another so as to insure maximum duration of information interaction (radiotechnical contact range and information contact) with various kinds of space apparatuses with different kinds of orbits (circular, elliptical, stationary and so forth).

One typical feature in the control of space objects in near space (several hundred kilometers from the Earth's surface) is the need to use measurement, monitoring and control stations across the entire territory of the country and even the world. The fact is that the time that a satellite is within the zone of radio contact with a tracking station lasts only several minutes. But in a number of cases, as long an information contact as possible with the controlled object is desirable for control. This is why as one point ends its work, another must take over, and it is best when this relay continues uninterrupted, if, of course, the task has not been set of insuring reliable control while having restricted information contact with the object.

Since even across the territory of our country uninterrupted contact with a space object in near space can be insured only for 20-25 minutes (while the period of orbit is 90-100 minutes), in order to extend the zone of information interaction with the space object, special points have been set up in the world's oceans by ships of the USSR Academy of Sciences, which in terms of their facilities are identical to individual systems or fixed command-measurement points in general. In the terminology of the command-measurement complex they are shipborne command-measurement points. They are "arranged" along a track in strict accordance with the recommendations of the "ballistics people" who are trying to insure uninterrupted observation of the flight of a space vehicle. And an inexperienced person listening to the control center radio contacts with cosmonauts is virtually unable to tell where communication with one station stops and another starts. For the orbit of the "Salyut"-"Soyuz" class, because of the Earth's rotation, on 5 or 6 out of every 16 days they are not "visible" from the fixed ground points located in the territory of the Soviet Union even though its "geography" is extremely extensive from north to south and from the western borders to the Far East and Kamchatka.

Moreover, a number of particularly crucial operations (the start of docking, work with the braking engine) take place above the Atlantic Ocean and monitoring of these operations is possible only with the aid of the shipborne points. And on the very first orbit the shipborne command-measurement points can extend the zone of active contact with a space vehicle.

The "Kosmonavt Yuriy Gagarin," the "Kosmonavt Vladimir Komarov" and the "Akademik Sergey Korolev" with displacements of 17,500 to 45,000 tons, form the basis of the shipborne command-measurement points.

Another more numerous groups of ships makes up the floating radiotelemetry complexes: the "Komsonavt Pavel Belyayev," the "Kosmonavt Vladislav Volkov," the "Komsonavt Georgiy Dobrovol'skiy," and the "Kosmonavt Viktor Patsayev." Their displacements are up to 9,000 tons. This group of shipborne points monitors the status of objects in space and provides radio communications with the crew. Modern computer facilities and satellite communications systems enable automated processing and transmission of telemetry information to the control center, and also two-way communications between control personnel and crews.

Depending on the specific task and the technical equipment, the shipborne command-measurement points are based in the western areas of the Atlantic and Pacific oceans and the Mediterranean.

For occasional operations, in order to insure uninterrupted communications with space apparatuses on especially important parts of a flight (if this cannot be done by fixed points or it is impossible, and sometimes inexpedient, to use the ships) aircraft are used.

In contrast to the United States, where in essence the tracking networks for space objects are departmentalized, the Soviet Union has at its disposal a powerful universal complex and network of stations that make it possible to maneuver flexibly and spread monitoring and control resources for different tasks being carried out in space.

Flight control centers equipped with the latest computers able to operate at a combined speed of tens of millions of operations a second, communications facilities, television, documentation for information, remote passing of commands, crew communications facilities and so forth are set up in order to standardize control methods, reduce the complexity of software, take into account the specific nature of control and determine types of space vehicles.

Some centers have at their disposal a complex of simulation facilities, including mathematical and physical models of the vehicle. The control center interacts with the cosmodrome and the organizations participating in control and in obtaining the information they need.

The command-measurement points are linked to each other and to the flight control center by cable, radio relays lines and satellite communications channels.

It is apropos to note that the concept of "command-measurement point" has been retained by tradition right from the start of the space age. At that time a "point" really was a point: a mobile station and facilities for insuring its operation. Today it is a whole organization with essential services, capable of functioning autonomously. It is an entire complex of various kinds of complicated radiotechnical facilities with a high level of automation and exceptional accuracy in measurements, with a range of several thousand to hundreds of millions of kilometers. Together with the ships and aircraft these stations make up, in essence, a single tracking network for artificial Earth satellites and space vehicles and the monitoring and control.

The distribution and redistribution of monitoring and control facilities and operational replanning of facilities and the resolution of "conflict" situations are effected by a service in the coordination-computer center.

The coordination-computer center and the flight control centers are the chief organs of the command-measurement complex. They coordinate the work of all services and facilities throughout the flight of a space apparatus and they also insure the necessary cooperation with the cosmodrome and the organizations interested in obtaining information, and if required, they correct a flight program.

The command-measurement complex includes command-program, trajectory, telemetry and television systems, systems for radio communications with the crew and satellite communications, a unified time system, automation and computer facilities, automated data processing complexes, and power supply systems. Many of them operate in "combined" modes when they simultaneously resolve trajectory problems, make telemetry measurements, pass commands and "lay in" control programs, and carry out communications and television tasks.

In recent years the command-measurement complex has received highly accurate laser radar equipment using the energy of a reflected laser beam.

The overall situation in space and the status of each space system, its stage of operation, the status of command-measurement complex facilities, the daily

and hourly operations plan and much else is displayed in the main hall of the coordination-computer center. During the launches of space apparatus there is television reportage direct from the cosmondrome. If required, using the archive retrieval system it is possible to call up from storage in the computer data complex interesting information on the object launched and to display it on individual or multi-user facilities. Real-time control presupposes that all kinds of measurement information is received and processed and that the control command is prepared, accepted and transmitted during the course of a single control session, that is, in 5 to 7 minutes (for space apparatuses in "near" space).

.... When you are in the flight control center and see how skillfully and precisely the operators carry out their duties you cannot immediately assess the colossal stress, importance and responsibility of the work that they are doing. For several dozen spaces apparatuses of various kinds are "working" in orbit at the same time: satellites studying the Earth's natural resources, "orbital meteorologists," space relay stations and navigation satellites, scientific satellites and satellites launched in accordance with international cooperation programs.

At a specified time each one of them is in the zone of radio contact for one of the points which is carrying out its work according to the program. Several space apparatuses using the same measurement facilities may be in the "zone" of a single point at the same time. It is necessary to "uncouple' the program and establish a sequence for the use of facilities and to carry out all planned control operations regardless of the time of day, the weather conditions or other factors.

As a rule, each day several dynamic operations take place on which the further program depends: trajectory corrections, maneuvers, the reentry of descent apparatuses, the injection of a space apparatus into orbit.

The history of cosmonautics is still being filled with pages about new discoveries, new worlds, new victories in learning about the universe. And in each of them a deserved place will be given to the command-measurement complex. Possibly it will someday be called something else, its tasks may change, new measurement principles may appear, new facilities; but we shall never forget what the command-measurement complex did at the dawn of the space age.



9642
CSO: 1866/115

## NELEPO DESCRIBES 'INTERCOSMOS-BLACK SEA' EXPERIMENT

Moscow PRAVDA in Russian 9 Oct 83 p 3

[Article by B. Nelepo, director, Marine Hydrophysical Institute, Ukrainian SSR Academy of Sciences, academician, Ukrainian SSR Academy of Science, Sevastopol]

[Text] What can be seen in the ocean from space? Only six years ago, at the First All-Union Congress of Oceanologists, many specialists asserted that light scattering by the atmosphere certainly creates an impenetrable curtain for observation of processes at the ocean surface, much less in its deeper layers. But a series of excellent photographs of dynamically active regions of the ocean, obtained from orbit, made possible a new approach to the problem of observing them from great altitudes. It became clear that despite the influence of the atmosphere the study of the ocean from space in the visible range of the spectrum is possible under definite observation conditions.

In order to clarify these conditions the oceanographic satellites "Cosmos-1076" and "Cosmos-1151" were launched, carrying automatic instruments aboard intended for study of optical phenomena in the ocean-atmosphere system. During this same period the multichannel MKS spectrometer, developed jointly with GDR scientists, operated excellently in orbit. It was installed aboard the satellites "Intercosmos-20" and "Intercosmos-21," also intended for study of the ocean. At the same time principles were formulated for the analysis of images obtained from satellites of the "Meteor" series and the best conditions were clarified for carrying out observations in the visible range.

However, this does not mean that the influence of the atmosphere can be ignored. Aerosols, water vapor and gases, complexly changing their composition with altitude, exert an appreciable influence on the accuracy of measurements. Even in the absence of clouds atmospheric haze frequently prevents visual observations and photography from space. But is this possibly a barrier only for human vision? If this is so, by means of spectral apparatus and special processing of images by means of an electronic computer this obstacle can be overcome. Specialists are now convinced of this.

In order to learn how to extract the maximum information from photographs it was decided to compare the results of simultaneously made measurements of the spectral composition of radiation in the sea, at different altitudes in the atmosphere and in space. This was precisely the idea behind the "Intercosmos-

Black Sea" experiment carried out in September of this year. The Marine Hydrophysical Institute, Ukrainian Academy of Sciences, for this experiment prepared two scientific research ships and an AN-30 aircraft laboratory. At the disposal of the experiment participants was an oceanographic platform situated at a depth of 32 meters and located a half-mile from the shore.

Representatives of the GDR, Mongolia, Poland and Romania, as well as specialists of the Space Research Institute and the Institute of Radio Engineering and Electronics, USSR Academy of Sciences, also participated in the experiment. The base for these operations was the division of the Marine Hydrophysical Institute, Ukrainian Academy of Sciences, at Katsiveli village, not far from Simeiz. A radio center and a station for the reception of information from meteorological satellites functioned there.

In addition, at our institute instruments were prepared for direct measurements in the sea at different depths, as well as spectral apparatus for remote sounding of the ocean from aboard a ship or aircraft. The scientists of our country and the GDR installed MKS-M multichannel spectrometers on the platform, on the scientific research ship "Professor Kolesnikov," and on the aircraft laboratory. Apparatus was delivered from Bulgaria which was employed in the work of the international group of scientists from the USSR, Mongolia, Poland and Romania. In addition, Polish scientific workers, using a four-zone camera, have now obtained matched images of the sea surface and its different depths. Instruments from the Institute of Radio Engineering and Electronics, USSR Academy of Sciences, also operated on the platform. This was for obtaining radar and radiothermal images of the water surface.

I wish to mention that hydrooptical measurements in the sea have been made by our institute for more than two decades. During the last four years aircraft and space investigations have become an important part of this work. Thus, the "Intercosmos-Black Sea" expedition for us is one of the stages on the way to creating a permanently operating system for observations of the ocean.

The experiment was carried out in the following way. V. Lyakhov and A. Aleksandrov worked during the transit of the "Salyut-7" over the Black Sea, the AN-30 aircraft observatory flew along the route, multisided investigations were carried out from aboard the scientific research ship "Professor Kolesnikov" and the oceanographic platform, while the ship "Kometa" carried out a speedy hydrophysical survey of the region. Data from the "Meteor" satellites were used at the same time. They were sent to on-shore, shipboard and aircraft image reception stations. Figuratively speaking, there was a simultaneous multistage investigation of the sea and the atmosphere above it.

An important part of the entire experiment was the joint use of two instruments: multizonal camera (MKF-6M) and multichannel spectrometer (MKS-M). Work with these instruments was carried out by specialists of the Space Research Institute, USSR Academy of Sciences, and the Marine Hydrophysical Institute in collaboration with GDR scientists. I note that whereas the MKF camera was "assigned" to orbital stations long ago, the MKS spectrometer was modified and installed aboard the "Salyut-7." The very same instruments operated aboard the aircraft laboratory, making measurements and taking photographs from different altitudes.

The question can arise as to why it is necessary to fly into space for study of the ocean. The fact is that the ocean is so extensive that it requires the creation of observation tools which will make it possible to monitor dynamic processes in the ocean routinely and on a global scale. We already know the principal forces, from the hydrodynamic point of view, which determine the life of the ocean in all its diversity. Solar energy creates thermal contrasts resulting in the appearance of movements in the ocean-atmosphere system. The earth's rotation dictates a direction of movement which affects the entire thickness of the ocean and is dependent on bottom relief and the nature of the shoreline.

If we mentally glance into the ocean as a whole, we see gigantic circulation rings occupying it from shore to shore. These rings pulsate, change form and interact with one another. The particularly strong jet currents of the Gulf Stream or Kuroshio type arise at the boundaries of these circulations. These currents branch out, constantly varying their "channel." Sometimes the loops are closed and then circulation rings with dimensions of hundreds of kilometers are detached from the system. Upon separating from the main current they wander for years in the ocean, sometimes disappearing, but at times streaming into the current generating them. In addition, still larger circulations, attaining 500 km in diameter, move over extensive ocean areas. In these circulations, depending on the direction of rotation, the water masses rise or subside, which determines many characteristics of development of life in the ocean.

The variability of the state of the ocean is also dependent on the intensity of wave processes at the surface and in the deeper layers. The existence of layers of different density creates a possibility for the development of deep "storms" -- internal waves, the amplitudes of whose oscillations can exceed a hundred meters. Such a complex "breathing" system of interacting processes with a lifetime from minutes to several years is characteristic for the ocean as a whole. Changes in oceanic circulation exert an influence on the transfer of heat and thereby cause weather oscillations. With complex oscillations of jet currents and layers of different density,conditions arise in the ocean for the formation of productive zones which are displaced, concentrated or scattered under the influence of hydrophysical processes.

I add that all these phenomena in turn control the multistage chemical and other processes acting on bioproductivity and the course of mineral formation at the bottom.

Information on the thermal and dynamic state of the ocean is also necessary in the support of navigation and shipping. And long-range forecasts of weather and climatic fluctuations are possible only on the basis of a knowledge of ocean physics.

Thus, the most important problem in oceanology is the development of methods for predicting the state of the ocean, and this means also a system of observations of state of the ocean. Without question it will be possible to do this only by bringing together the efforts of scientists in many countries and by using global scanning systems based on satellite observations.

And still another question: is it possible to see the ocean depths from space? The results of work with automatic satellites and especially from the "Cosmos-1151" indicated that the ocean surface serves as a large "screen" on which processes transpiring in its depths are reflected. I note that the approaches used today for study of hydrophysical structures, based on an analysis of photographs from space, are applicable to any images obtained in a wide spectral range. That is why the experiment in the Black Sea is of great importance for space hydrophysics in general.

Even after the orbital station, entering into the shadow zone, ceased to "see" the Black Sea during the daytime, the ship "Professor Kolesnikov" continued the expedition, combining shipboard investigations with aircraft measurements and an analysis of the images transmitted from the meteorological "Meteor" satellites. Lying ahead is a careful analysis of the collected data, new results and discoveries in learning the secrets of the ocean.

5303
CSO: 1866/18

'COSMOS-1500' SLR USED FOR ARCTIC ICE RECONNAISSANCE

Moscow IZVESTIYA in Russian 6 Nov 83 p 6

[Article by V. Shmyganovskiy : "A Space Pilot for the Nuclear-Powered Icebreakers"]

[Text] The very difficult present navigation in the eastern of the Arctic has required the use of the latest achievements of science and the most efficient technical facilities--primarily for the purpose of ice reconnaissance.

Striking results have been achieved using a side-looking radar for remote sounding of the environment, developed at the Ukrainian SSR Academy of Sciences Institute of Radio Physics and Electronics (Kharkov) and mounted aboard the "Cosmos-1500" satellite. Neither snow storms nor the polar night can stop it from conducting strategic reconnaissance of the ice fields in the grimmest of the oceans.

Altitude makes many of our concepts of the power of ships, distances and the reliability of weather forecasts relative. Just take off in an Mi-2 helicopter from the stern deck of a nuclear icebreaker smashing its way through the ice and rise up above the sea, and a gigantic ship seems like a mechanical toy made in a factory. Just like a steel dimwit it noses its way into one ice dam after another and cannot follow the course it wants to.

But the hydrologist notes the weakest point. It lies somewhat off to the side. But, of course, in the Arctic the shortest course is not necessarily the most direct one but the simpler one. In order to avoid losing time in "matching" the bearings from the ice and from the air, the helicopter bravely plunges down to the freezing and steaming clearing and "squats" ahead of the stranded ship, inviting it to follow.

The Il-14 flying laboratories conduct more solid reconnaissance work. They fly aloft for hours on end after waiting for the first "window" in the weather, in order to make the precise drop onto the deck of the nuclear-powered icebreaker, using a message bag with a hand-drawn map and the words of text: "Move closer to the offshore ice," and the immediate clarification: "if it is deep enough."

And finally, at the very highest level, "the captain's bridge" of the ice patrol, the satellites are on watch. In good weather they provide precise

pictures of enormous territories. In good weather... But what about in a blizzard, in fog, when there is a thick cloud cover? Until recently the satellites were impotent here. And the "Cosmos-1500," launched on 28 September this year, came at just the right time for the polar mariners, the meteorologists, the hydrologists; for many people in our national economy now need its apparatus, developed by the people in Kharkov.

"The first strategic reconnaissance using the side-looking radar was done at our request early in October," the deputy chief of the Maritime Fleet Northern Sea Route Administration, G. Burkov, tells us. "And from the height of space we saw that the situation in the Long Strait and around Wrangel Island was very complex as far north as the Pole. But the view from orbit helped to assess the prospects for shipping movement: they could turn back to Vladivostok or break through to Pevek nevertheless. The satellite predicted that there is some hope for success. The final decision was made in Pevek."

... I am looking at the radio map of these latitudes. If you can read the pictures taken from space using the optical instruments it is not so difficult to understand the artistry of the radar. The picture shows a band about 460 kilometers wide. The two capes, on Chukotka and Wrangel Island, reach out for each other, separated by the Long Strait, like arrowheads. The light and light-gray colors--ice, ice, ice--are solid right up to the roof of the world... To the south and southwest the color is dark around the islands; this is clear water and thin, newly formed ice.

You get the same sort of impression when you look at our world through a microscope. And here, too, there should be some movement not visible to the naked eye. Here is such a "particle." An iceberg measuring about 15 kilometers across is plowing its way through the ice pack leaving quite a broad open track in its wake. This kind of mighty, drifting iceflow is an ideal site for a "Severnyy polyus" station. They are very difficult to find in the vast stretches of the Arctic.

Alas! the pictures of the same region taken over the course of the next week were disappointing: the ocean had firmly widened the open space and the iceflow had evidently slowed considerably.

It is difficult to overestimate the significance of this aide in the dark winter, when ships along the Murmansk-Dudinka route sometimes steam without any reconnaissance ahead. True, some years ago I was able to participate in tests of a special "nighttime" helicopter. The ace of ice reconnaissance Ruslan Aleksandrovich Borisov flew with test pilot Nikolay Pavlovich Bezdetnov and navigator Mikhail Ivanovich Ryabov.

They took off from the nuclear-powered icebreaker "Sibir'" in a crackling frost and vanished into the immense darkness, leaving the captains of the rare ships with the puzzling thought: what kind of daredevil would risk flying over the Arctic at such a time?! They studied the ice with electronic instruments but Borisov, hydrologist through and through, just had to "feel its pulse" visually. So then they descended to a height of 20 or 15 meters and switched on the six powerful searchlights that could be seen from aboard the icebreaker from a distance of 100 or more kilometers.

G. Burkov continued the story: "Now, when the new helicopter--the K-32--has been developed for the Arctic, it can, in its 'ice' version, successfully carry out tactical reconnaissance at any time of the year, in minimum weather conditions. It is not difficult to predict that with unhampered movement through space, shipping movement along this route will be accelerated..."

On 10 November, it is also planned to "switch" the satellite to reconnaissance of the western region of the northern sea route where the most difficult navigational period of the year is starting. The reconnaissance will extend right to the crushing drift ice on the Yenisey which carries down to the port of Dudinka so much ice that the water level rises.

But the port is being regenerated, phoenixlike, and come what may it will start its work. And it is the same every year! No engineering decision has yet been devised capable of protecting the national economy from the annual tribute of almost R1 million that must be paid to the river. This means that the more the port is used in winter the less these losses are felt.

Here, strategic ice reconniassance is decisive.

It should be said that in terms of territory covered and the feasibility of providing operational information directly to users--to the headquarters of the maritime pilots, the icebreakers and the weather stations--the radar has no equal anywhere in the world.

Riding on their success, the researchers plan immediately to compile radar maps of the ice situation throughout the Arctic. Data will be collected over a 3-day period and transmitted to Khabarovsk, Novosibirsk and Moscow. Aircraft will deliver the information obtained to the capital. After processing of the materials, the map can be ready in only 10 days.

Previously this work took months...

9642
CSO: 1866/34

UDC 551.583:341.12

# VARIABILITY OF RADIATION BALANCE IN NORTH ATLANTIC ACCORDING TO SATELLITE MEASUREMENT DATA

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 272, No 5, Oct 83 (manuscript received 20 Apr 83) pp 1099-1102

MARCHUK, G. I., academician, KONDRAT'YEV, K. Ya., corresponding member, USSR Academy of Sciences, and KOZODEROV, V. V., Computational Mathematics Division, USSR Academy of Sciences, Moscow

[Abstract] Observations from earth satellites make possible continuous monitoring of the radiation balance. The importance of these measurements is increasing due to the discovery of energy-active zones in the ocean. However, the study of such zones in the North Atlantic is difficult due to their smallness in comparison with the area of the ocean. A study along these lines was made using measurements with a scanning radiometer for a period of 45 months (1974-1978), the objective being an analysis of the year-to-year variability of the radiation balance (the measure of variability was the dispersion of all 45-month data relative to the mean monthly values within grid squares 2.5° x 2.5°). Comparison with direct shipboard radiation measurements was possible by reduction of satellite measurements to the earth's surface. The components of the surface radiation balance were retrieved from mean monthly satellite data using definite sets of approximation coefficients. Figure 1 shows the distribution of the mean radiation balance values for the earth-atmosphere system according to satellite measurements and after their reduction to the level of the earth's surface; Figure 2 shows two corresponding maps of isolines of dispersions of mean radiation balance values. Comparison with direct shipboard measurements gave fairly good results. It is shown that the pattern of year-to-year variability is governed primarily by the long-wave component and to a lesser degree by absorbed radiation. The energy-active zones in the North Atlantic are related primarily to a considerable variability in heat exchange between the ocean and the atmosphere. The concept of energy-active zones, initiatly based on numerical modeling, is experimentally confirmed by these data on the radiation balance. Satellite monitoring of the earth's radiation balance is both feasible and expedient. Figures 2; references 13: 5 Russian, 8 Western.
[22-5303]

UDC 551.534

POSSIBILITY OF VISUAL MONITORING OF STATUS OF OZONOSPHERE FROM ORBITAL STATION

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 271, No 1, Jul 83 (manuscript received 15 Feb 83) pp 76-80

GRECHKO, G. M., YELANSKIY, N. F., SAVCHENKO, S. A. and TEREKHIN, Yu. L., Institute of Physics of the Atmosphere, USSR Academy of Sciences; Institute of Space Research, USSR Academy of Sciences, Moscow

[Abstract] Spectral brightness in the Earth's twilight halo as a function of atmospheric ozone and the stratification of the blue bands observed visually were studied by doing numerical calculations of spectral brightness for an atmosphere with an irregular distribution of ozone and aerosol and by analyzing the correlation between the position of the blue bands and the known distribution of ozone in the atmosphere, using material obtained from observations aboard the "Salyut-6" orbital station during the period December 1977 through March 1978. Calculations were made of vertical profiles of spectral brightness in the twilight halo with the Sun at angles of 3-15° below the horizon and used to construct a color picture of the twilight halo. The layered structure of the bands is constant for all types of distribution from equatorial to the high latitudes; all layers are grouped close to several levels whose altitudes match the altitude of the upper and lower boundaries of the types of vertical distribution, at 16.5, 20, 25, 28, 30.5, 33.5 and 38 km. It is concluded that the position and form of a blue band and the features of its internal structure are determined by the status of the stratospheric ozone layer. The findings show the great potential for visual and photographic observations along the vertical for determining the global distribution of ozone and studying the effect of large-scale dynamic processes on it. Observations could be conducted by regular panoramic surveys made from orbital stations. Figures 2; references 15: 13 Russian, 2 Western.
[176-9642]

UDC 551.46.0: 629.78 + 528.7

DETERMINING COMPONENTS IN RADIATION BUDGET OF EARTH'S SURFACE USING SATELLITE MEASUREMENTS

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 83 (manuscript received 5 Jan 83) pp 5-17

KOZODEROV, V. V., Department of Computer Mathematics, USSR Academy of Sciences, Moscow

[Abstract] The role of satellite measurements is discussed in the context of the detection of anomalous, long-duration energy zones in the world

oceans and associated climatic changes. Existing regression methods for reconstructing the longwave and shortwave components of the Earth's radiation budget and the corresponding empirical methods do not provide adequate accuracy in albedo determination. A two-group approximation model is presented for solving boundary problems for shortwave radiation corresponding to direct and scattered solar energy at wavelengths of 0.3 to 7 micrometers and for longwave radiation corresponding to atmospheric and terrestrial inherent radiation at 2 to 100 micrometers. It is shown that by first averaging the cross sections and indicatrices and then solving the boundary problem only for each of the two groups of photons for solar and inherent thermal radiation it is possible to save considerable time and labor. The model is worked numerically and results are compared with those obtained using other methods. Figures 2; references 15: 9 Russian, 6 Western.
[183-9642]

UDC (551.501.724 + 551.501.74): 525.73

SIMULATION AND STATISTICAL INVESTIGATION OF REFRACTOMETRIC METHOD FOR DETERMINATION OF METEOROLOGICAL PARAMETERS FROM SPACE

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 83 (manuscript received 22 Sep 82) pp 25-32

GAYKOVICH, K. P. and NAUMOV, A. P., Scientific Research Institute of Radiophysics, Gorkiy

[Abstract] Recent work in obtaining current information on the fine structure of meteorological elements from the refractive characteristics of optical radiation from astronomical objects (Sun, Moon, stars) prompted a study of refractometric methods using observation data obtained from aboard the "Salyut-6" space station and from about 100 aerological soundings made in the European part of the USSR over a 4-year period. Numerical statistical studies enabled determination of marked changes in pressure and temperature gradients as a function of altitude and their correlation with image reconstruction problem. Results show that when using refractometric methods corrections must be made for relative error in refraction measurements by using aerological sounding readings to supplement satellite data. The refractometric method is compared with other remote sensing methods used to obtain meteorological data from space observations (radiothermal, laser). Figures 3; references 17: 15 Russian, 2 Western.
[183-9642]

UDC 551.51: 629.78

FEASIBILITY OF REMOTE DETERMINATION OF ATMOSPHERIC PRESSURE FROM ARTIFICIAL EARTH SATELLITES USING RADIOMETRIC METHOD

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 83 (manuscript received 6 Oct 82) pp 33-38

TROITSKIY, A. V., Scientific Research Institute of Radiophysics, Gorkiy

[Abstract] The feasibility is studied of using remote radiometric methods to determine atmospheric pressure from drifting atmospheric radiation on the absorption lines of molecular oxygen at lambda = 5 and 2.53 mm. The mathematical apparatus is discussed, taking into consideration temperature and humidity effects. The problem is worked using data obtained aboard an aircraft flying routes over the Black Sea using a frequency of 51 GHz which is shown to offer maximum radiometric sensitivity. Results are compared with known pressure data along the routes flown by the aircraft and found to be accurate within 2 mb. It is concluded that it is feasible to use radiometric methods from space vehicles to measure atmospheric pressure with sufficient accuracy, but it is pointed out that the experimental results used in the study were obtained in a cloudless sky, while the presence of a cloud cover makes observations more complex because of the water content in the clouds. Figures 2; references 6: 4 Russian, 2 Western.
[183-9642]

UDC 528.77: 550.814 + 629.78

BASIC PARAMETERS OF SPACE PICTURES FROM VIEWPOINT OF THEIR GEOLOGICAL INFORMATION

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 83 (manuscript received 7 Feb 83) pp 39-46

BRYUKHANOV, V. N., All-Union Scientific Research Institute of Geology of Foreign Countries, Moscow

[Abstract] The geological interpretation of pictures of the Earth taken from space is discussed. The key elements in a picture are scale and resolution, which in turn determine the scales of objects, field of vision, and the degree of contrast for geological bodies that differ in terms of spectral brightness. Image generalization for geological interpretation of space pictures depends on image scale and is associated with reducing resolution and increasing the space vehicle's field of vision. In the USSR geological maps are usually compiled on scales ranging from 1:15,000,000 to 1:25,000; a detailed breakdown of the classification is shown both for scale and type of imaging (scanning, photographic, infrared). Fields of vision range from 10 million square kilometers to 400 square kilometers; details

are given. The most frequently used spectral channels in the visible and near-infrared are 0.5-0.6, 0.6-0.7, 0.7-0.8 and 0.8-1.0 (or 1.1) micrometers, although there has been a recent increase in the use of longer wavelengths. The work of Soviet and American scientists in interpretation of spectral characteristics is described. The classification of geological information obtained from space pictures is examined. References 10 (Russian).
[183-9642]

UDC 528.77 + 629.78: 551.25(571.6)

TRANSREGIONAL FAULTS IN NORTHEAST USSR SEEN ON SPACE PICTURES

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 83 (manuscript received 1 Dec 82) pp 54-58

FILATOVA, N. I., "Aerogeologiya" Production Geological Association, Moscow

[Abstract] An analysis is made of transregional faults in two tectonic regions of the northeast USSR, namely the Verkhoyano-Chukotsk (preriphean continent experiencing partial Phenerozoic rift formation) and the Koryaksko-Kamchatka (transitory crust formed during the Mezozoic-Cenozoic), as seen from space pictures. The length of the faults on the territory surveyed extends beyond 1,000 kilometers and faults are not bounded by the shorelines but in some cases extend out into the Pacific Ocean. Transregional faults appear to lie in a pattern at intervals of 50-100 kilometers and they pass through quite different kinds of tectonic structures: within the limits of the preriphean crust a single fault can be registered by facies of Paleozoic and Mezozoic formations, and on sections where the crust is being formed they are seen in Cenozoic magma formations. The faults lying along latitudinal lines form at least five different systems. Those oriented longitudinally form several major subparallel components up to 100-150 kilometers wide. Details of faults in the area surveyed are given and their geological and geophysical significance is discussed. It is concluded that these faults are of very great geological age and are distinguished by the great depth of their horizons. The role of the faults in tectonic processes is examined. The analytical results show that pictures taken from space can be of great importance in providing new information on the structure of the Earth's crust on the global scale. Figures 1; references 4 (Russian).
[183-9642]

UDC 528.77 + 629.78: 551.24(575)

USE OF SPACE IMAGES FOR ANALYSIS OF LATEST TECTONIC MOVEMENT (USING AMU-DARYA DELTA AS EXAMPLE)

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 83 (manuscript received 18 Nov 82) pp 59-63

BURLESHIN, M. I., All-Union Scientific Research Institute of Hydrogeology and Engineering Geology, Moscow

[Abstract] Comparison of tectonic and geological interpretation of space images with data obtained from ground observations shows that information obtained from space images can be divided into two parts, namely information on elements of geological structures that can be confirmed relatively simply by comparison with data from other sources, and new tectonic information that is sometimes impossible to obtain by any other means. This information is of great interest to geologists but confirmation problems are more complex than the interpretation itself. This fact prompted a study of interpretation of geological data derived from space images using as an example space images of the Amu-Darya delta region and analysis of topographical maps of the Turan plate and the region adjacent to it. Structual and tectonic diagrams of the Amu-Darya delta are presented and discussed in the context of using ground observation data to confirm space data. Analytical results show a relationship between transverse structural zones and changes in the strike of submeridional faults and emergence of fold apices. It is appropriate to use data from ground observations (analysis of strength and composition of new deposits, repeat levelling and so forth) to confirm space data on new tectonic processes. This study of the Amu-Darya delta zone has practical significance in indicating possible oil deposits and in plans for land reclamation work. Figures 2; references 6 (Russian).
[183-9642]

UDC (528.77 + 629.78): 551.25

ANALYSIS OF FRACTURING FROM INTERPRETATION OF SPACE IMAGES (USING PECHENGA MINING ZONE AS EXAMPLE)

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 83 (manuscript received 18 Nov 82) pp 64-69

GRACHEV, A. F., FELITSYN, S. B., BABICH, N. A., MISHIN, V. I. and FILIPPOV, N. B., Earth Physics Institute imeni O. Yu. Shmidt, USSR Academy of Sciences, Moscow; "Sevzapgeologiya" Production Geological Association, Leningrad

[Abstract] Results are presented from a study of the Pechenga mining zone using aerial and space images processed using the ASOI-Geologiya software developed at the "Sevzapgeologiya" computer center. Interpretation was done

in two stages: first, lineamental lines were constructed for the entire plot of the area being studied using basic 5 x 5 cm cells, and then in the second stage, only the lineaments of tuff-formation and sedimentation thickness were examined using a scale of 1:10,000. Analysis of the lineamental structures in the Pechenga mining zone combined with geochemical data on nickel and copper concentrations enabled the zone to be precisely delineated and differences in the structural picture of ore-bearing and non-ore-bearing fields to be determined from the relationship between the degree of fracturing along the northwest, northeast and latitudinal strikes and the different roles of fractures in these strikes during the process of ore formation, thus making it possible to use fracturing data to evaluate promising ore-bearing fields in the Pechenga structure. The results can be of use in similar regional studies to determine the presence of copper and nickel sulfide ores. Figures 6; references 8 (Russian).
[183-9642]

UDC 631.4: 629.78

METHOD FOR PHENOLOGICAL OBSERVATIONS WHEN MEASURING COEFFICIENTS OF SPECTRAL BRIGHTNESS FOR PLANT COVER

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 83 (manuscript received 18 Nov 82) pp 78-82

KHARIN, N. G., KIRIL'TSEVA, A. A. and ROZHKEYEV, A. G., Deserts Institute, Turkmen SSR Academy of Sciences, Ashkhabad

[Abstract] A method for quantitative evaluation of the phenological status of plant cover using remote sensing of plant spectral brightness is considered. The method consists first of establishing a recording unit for observations (a leaf, a branch, a tree, and for small plants an area of specific dimensions) and then determining the phenological phases and boundaries. The phenological sequence for distribution of spectral brightness then provides a basis for constructing a phenological model of a process being studied, and results can be presented in the form of distribution tables or graphically in the form of histograms. The method is worked using data from studies conducted in 1977-1978 in Central Kopetdag in the Turkmen SSR. It is shown that the method can also be used in studies of agricultural crops. Use of the coefficients of spectral brightness helps in standardizing measurement methods, improves the reliability of measurements, makes results found by different researchers comparable, helps in building up information on phenological models for various kinds of plant cover and aids in solving the problem of determining the status of the plant cover from measurements of spectral brightness. Figures 4; references 8 (Russian).
[183-9642]

UDC 551.467: 629.78

FEASIBILITY STUDY FOR REMOTE DETERMINATION OF GEOMETRIC CHARACTERISTICS OF SURFACES WITH MAJOR IRREGULARITIES USING MICROWAVE RADIOMETRIC MEASUREMENTS

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 83 (manuscript received 4 Aug 82) pp 83-89

VLASOV, A. A. and SHESTOPALOV, Yu. K.

[Abstract] Existing models used to calculate the parameters of major geometric irregularities on the Earth's surface are suitable only for relatively small-scale features. In this study an attempt is made to determine the feasibility of using an approximation model of the radiating medium on the Earth's surface by examining the aggregate of cones of various heights on a flat surface. Emmissivity in such a model equals the weighted sum of the emissivities of the individual cones and the plane sections of the surface in the direction of the observation and the problem consists in determining emissivity for a single cone whose area is less than that of the radiometry antenna coverage on the Earth's surface at a random angle of observation. The mathematical apparatus of the model is shown and results are presented from machine processing of the problem. Model experiments on the ground to confirm the theoretical dependencies are described. The model is used to process radiometry data on sand dunes obtained from aboard the "Cosmos-1151" satellite to determine the mean slope of the sides. Results are compared with geographical data on the relief of the sand dune region and error is found to be less than 3°. Figures 4; references 6 (Russian). [183-9642]

UDC 535.361.2 + 57.084.2: 535.232.65

HOT SPOT EFFECT OF HOMOGENOUS PLANT COVER

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 83 (manuscript received 18 Jan 83) pp 90-99

KUUSK, A., Institute of Astrophysics and Atmospheric Physics, Estonian SSR Academy of Sciences, Tartu

[Abstract] Proceeding from Ross and Nilson's theoretical consideration of plant cover as a plate medium the uathor considers a horizontal plane-parallel turbid medium consisting of thin opaque plates located in a layer $z = 0$ to $z = H$ in a specific way, with $z = 0$ corresponding to the upper boundary and $z = H$ corresponding to the lower boundary of the medium. The structure of this medium is described from the total area of the upper side of the plate within the unit of volume about point P (the density of the plate area), the index for the plate area, the density of normal distribution on the plates, projection of a unit area on a plane perpendicular to the direction of r, and the indicatrix for scattering of the elementary layer Deltaz in the plate medium for an area unit on the plate. Constraints are

specified and a numerical calculation is done. It is shown that in a general case, the probability of observing illuminated elements in the plate medium is determined by the profile of the plate area, the orientation of the plates and the coefficient of mutual correlation. Calculated results are compared with measured values and good qualitative agreement is found. Substantive checking of the model's suitability for describing reflected radiation from a plant cover requires special measurements from a stabilized platform, and even then, disregarding the correlation in the location of plant elements can lead to uncontrolled error. Figures 5; references 17: 12 Russian, 5 Western.
[183-9642]

UDC 550.814: 681.3

ANALYSIS AND ISOLATION OF OIL AND GAS BEARING FIELDS BY ENHANCING SPACE PHOTOGRAPHIC IMAGES

Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 4, Jul-Aug 83 (manuscript received 19 Aug 82) pp 113-119

SMIRNOV, M. V. and ROZANOV, L. N., All-Union Scientific Research Petroleum Institute, Leningrad

[Abstract] Methodology is examined for the conversion and analysis of brightness coefficients on space photographic images studied with a view to distinguishing oil-bearing regions. Consideration must be given to factors influencing the optical characteristics of natural formations; these include moisture, unevenness of illumination, atmospheric effects and seasonal effects. Methodology for image analysis is considered: input data for machine processing should include appropriate maps showing known oil and gas deposits together with the space images, and low-frequency filters should be used for image enhancement. Geological interpretation of results from machine processing is discussed using as examples data on areas along the lower course of the Pechora River and in Orenburg Oblast. Figures 6; references 18 (Russian).
[183-9642]

## PRAVDA SCORES U.S. REACTION TO DRAFT TREATY ON USE OF FORCE IN SPACE

Moscow PRAVDA in Russian 24 Sep 83 p 4

[Article by A. Sitnikov: "Prevent the Militarization of Space: Disarmament is a Demand of Reason"]

[Text] The Soviet Union recently undertook still another step of extraordinary importance aimed at eliminating the threat of nuclear war and curbing the arms race. In a talk with American senators Comrade Yu. V. Andropov set forth major USSR initiatives to prevent the militarization of space which envisage adoption of a set of measures capable of averting the danger that the arms race will spread to space.

The USSR made corresponding proposals for examination by the recently convened 38th UN General Assembly session. First Deputy Chairman of the USSR Council of Ministers A. A. Gromyko sent a letter to the UN general secretary with a proposal to include in the session agenda the question "On Concluding a Treaty Prohibiting Use of Force in Outer Space and from Space toward the Earth," at the same time forwarding a Soviet draft treaty on this question.

The acuteness and urgency of the task of preventing the militarization of space increases with each passing day. Having set for itself the futile objective of achieving military supremacy, the United States is carrying out a program of developing space attack weapons intended for destroying objects in space and on Earth along with its creation of an entire series of new strategic nuclear arms systems and its plans for stationing new medium-range nuclear missiles in Western Europe. Enormous funds which are increasing every year are being directed to the achievement of military space goals. Expenditures in the United States for military research connected with space already have exceeded those for civilian needs in this area and continue to increase faster even in comparison with the unprecedented growth of the American military budget as a whole. According to preliminary estimates by authors of a draft resolution presented for U.S. Senate discussion proposing renewal of talks between the United States and the Soviet Union about prohibiting antisatellite systems, American taxpayers will have to pay around a hundred billion dollars for the creation of space weapons as they now are being planned by the Pentagon.

Overseas militaristic circles view military space systems as one of the key elements of a nuclear first strike potential. According to a directive President Reagan issued in July 1982, U.S. efforts in space development for the upcoming decade are oriented on creating a number of new weapon systems and deploying them in orbits. Special emphasis is being placed on the accelerated development of systems intended for destroying satellites. An antisatellite system using F-15 fighters is being tested at an accelerated rate and is to be adopted as early as 1987. Great hopes for attainment of a dominant U.S. position in space are being placed on the Shuttle-type reusable manned craft, the development of which is subordinated almost wholly to Pentagon goals. Variants of the use of these craft for placing various kinds of antisatellite weapons into orbit are being tested. These craft themselves are planned for use as antisatellite means and weapon platforms for the destruction of targets on Earth and in airspace.

The vain hopes to return America's past nuclear invulnerability in combination with the greediness of the military-industrial complex,which dreams about profits of truly cosmic proportions from the arms race, are the actuating springs of a decision made by the American administration in March on carrying out a program for creating a "broad scale" system of antimissile defense (ABM) on the basis of the latest technical achievements. It is planned to use laser, beam and other newest means of destruction deployed in space orbits for this system. Assertions of a "defensive" character of such weapons are intended for uninformed people.

The Pentagon is shifting from programs for the development of space attack systems and advancement of the military-strategic concepts of their employment to practical steps of arranging operational control of combat operations in space and from space. A special U.S. Air Force Space Command has been set up for these purposes.

Extension of the arms race to space would give it a qualitatively new and even more dangerous character. The development of various kinds and systems of space weapons would complicate greatly the achievement of international agreements on the control, limitation and reduction of arms. The deployment of weapons in space would open yet another broad channel of the arms race. The stern reality of the nuclear missile age is such that space weapons are intended not only for "star duels" but also for conducting nuclear war on Earth with all its pernicious consequences for nations. The creation of space arms would have an extremely serious destabilizing effect on the strategic balance. There would be an increase many times over in the factor of unpredictability and an increased likelihood of the outbreak of nuclear war as a result of inadvertence or miscalculation.

The orbital deployment of various kinds of weapons, antisatellites and antimissile systems, no matter what peacemaking arguments were used to explain this outwardly, must, according to the concepts of those nurturing plans for establishing an American space hegemony, permit the United States to acquire a potential for delivering a disarming nuclear attack while avoiding equal retaliation for its own part. Calculations of this kind clearly are linked with doctrines of being first to use nuclear weapons.

Meanwhile, scientists and experts of the USSR, United States and other countries express an authoritative opinion with all definiteness to the effect that it will be impossible to create a reliable ABM system either at the present time or in the foreseeable future which could guarantee against nuclear retaliation. But the very spread of illusions concerning the possibility of sitting it out beneath a "laser umbrella" of ABM and antisatellites creates a nutritive medium for conducting extremely dangerous politics intended for blackmail and impunity in being first to use nuclear weapons.

Our country deems it insistently necessary to erect a reliable obstacle to plans for converting space into a source of deadly danger for mankind. The Soviet draft treaty presented in the United Nations proposes a general ban on use of force in outer space and from space against Earth with the use of space objects located in Earth orbits, on celestial bodies or placed in outer space by any other means as a means of destruction for this purpose. Parties to the treaty pledge not to destroy, damage, disrupt the normal functioning or change the flight path of other states' space objects. In conformity with the treaty its parties also would make clear and specific pledges for a total ban on testing and space deployment of any space-based weapon. It is proposed to resolve the issue of an antisatellite weapon fundamentally and fully: There are provisions for total rejection of testing and creation of new antisatellite systems as well as such systems which the states already have. In addition, it is proposed to prohibit the testing and use for military, including antisatellite, purposes of any manned spacecraft, the use of which must serve wholly for accomplishing scientific-technical and economic tasks.

The Soviet draft envisages monitoring procedures which assure reliability that its parties are fulfilling pledges.

The new Soviet initiative meets to a considerable extent the proposals and considerations of other states as expressed in the Committee on Disarmament, from the UN rostrum and at other international forums. An important feature of the draft is its combination of the political-legal pledges of states not to allow use of force toward each other in space and from space with the implementation of far-reaching steps of a material nature intended to prevent the militarization of outer space.

In addition to the indicated measures presented in the Soviet draft treaty, the Soviet Union, as Comrade Yu. V. Andropov declared, has pledged not to be first to place any kind of antisatellite weapon into outer space as a demonstration of good will. The unilateral moratorium on such launches is introduced for all time so long as other states including the United States refrain from placing any kind of antisatellite weapon into space.

These USSR proposals represent a consistent development of its fundamental line of preventing the spread of the arms race to space and ensuring its study and development for peaceful purposes in the interests of and for the welfare of all mankind. On behalf of this our country introduced a proposal in the United Nations in 1981 for concluding a treaty on banning the deployment of any kind of weapon in outer space.

The present Soviet initiative generated broad response throughout the world. It was perceived as the voice of reason and as the manifestation of the USSR's firm resolve to proceed along all avenues for curbing the arms race and preventing nuclear war. Many soberminded political and public figures, well-known scientists and prominent specialists on military affairs in the West take note of its constructive character.

Just how did official Washington react to the new Soviet peace initiative? This time it was deemed advisable there not to utter the usual "no" from the outset, as the American administration now has made the rule. A special statement by the U.S. State Department even said that the Soviet draft treaty "is being studied carefully." By the way, this was followed by a statement of Washington's official position. Its essence reduces to understating the significance of the initiative, distorting its very content and, even before a discussion of the Soviet draft treaty begins in the United Nations, sowing doubt in advance over the possibility of achieving practical agreements. The State Department asserts, for example, that the precise meaning of the proposal is "unknown" to it although it is extremely clear and specific. It is also asserted that "one of the basic deficiencies of the Soviet draft is the insufficiency of means of verification." The "inadmissible risk" is pointed out in connection with conclusion of the proposed treaty and a position is advanced that a moratorium on putting antisatellite weapons into orbit will give the USSR a unilateral advantage. Consequently, we have an almost complete set of stereotyped "arguments" which the U.S. administration uses to disrupt or block talks to curb the arms race, to justify the need for implementing unprecedented programs for creating new arms, and to throw overboard or undermine from within international agreements which already have been concluded.

As it follows from the State Department statement, the goal of U.S. politics continues to be to force ahead American programs for creating weapons to wage war in space and from space and not take effective steps against the militarization of outer space. This official Washington statement cannot help but place on guard all UN member nations which favor a peaceful space. No matter what propagandistic rope-walking is used in an attempt to conceal it, there are no justifications for the dangerous politics of extending the arms race to space.

We cannot allow space to be turned into a source of military danger and an arena of conflicts and confrontation. It must remain free of any weapon. That is the demand of nations and that is the task of the times. The USSR proposes taking up its solution without further procrastination.

The present UN General Assembly session must have its ponderable say in favor of a most rapid adoption of specific steps and for holding international talks to prevent an arms race in space.

6904
CSO: 1866/24

COMMENT ON DIRECT TELEVISION BROADCAST BY SATELLITE

Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 4, Apr 83 pp 44-45

[Article by A. Terekhov: "Space Television and the Law"]

[Text] A retransmitting satellite "hangs" high in space, several thousand kilometers above the Earth's surface. You turn on your television set and there flashes on the screen an image transmitted from a studio located, shall we say, on another continent. What kinds of transmissions await you? An objective chronicle of international events, or disinformation flavored with open slander against true socialism? A variety concert by true masters of culture, or a squalid film with a dozen murders that propagandizes the cult of violence? A soccer match between popular teams, or a taste of the adventures of some western film star?

With the development of space technology, direct television broadcasting (DBS) has become a reality: from studio to satellite to home television set. It can either contribute to the expansion of cultural exchanges and further closeness among the peoples of the world or it can drive them apart.

In an effort to eliminate the possibility of an undesirable development of events, the Soviet Union came forth with an initiative for the development of international legal standards defining the rights and obligations of states with respect to television broadcasting via satellites. In August 1972, USSR Minister of Foreign Affairs A.A. Gromyko sent the secretary general of the United Nations a letter proposing the inclusion of this point in the agenda of the 26th session of the General Assembly. The Soviet proposal was approved, and the United Nations' Committee on the Use of Space for Peaceful Purposes was charged with determining the principles regulating the activities of states in the field of direct television broadcasting.

This work proved to be both long and complicated. The reason for this was the position of the United States of America, which from the very beginning opposed international legal regulation in this area since, in its opinion, it undermines the principle of "freedom of information." Overcoming the resistance of the United States and its closest allies, the representatives of the USSR and the other socialist and developing countries persistently directed matters toward the development of international legal standards regulating activities in the area of direct television broadcasting.

With a great deal of effort, a number of principles were successfully agreed upon on the basis of mutual concessions and compromises. There remained essentially only

one point of disagreement. However, it was a key point. In accordance with it, transmissions to a foreign state can be realized only on the basis of agreements or understandings; that is, the clearly expressed consent of these states.

By advancing various demagogic pretexts and then openly abusing the United Nations' Committee on Space's accepted procedure for making decisions on the basis of unanimity, for a long time the representatives of the United States practically single-handedly blocked agreement on this principle and, thereby, completion of the work as a whole.

Under these conditions, and considering that the Committee on Space could not complete its work on the principles of DBS because of the United States' position, a group of developing countries introduced the draft of a resolution entitled "Principles of the Utilization by States of Artificial Earth Satellites for Direct Television Broadcasting" at the 27th session of the United Nations' General Assembly. On 10 December 1982, the resolution was adopted by an overwhelming majority in a voice vote. Only the United States and a few of its closest allies spoke against it.

The document that was adopted contains the principle upon which the Soviet Union stood: DBS to a foreign state can be implemented only on the basis of agreements or an understanding with it. It contains important provisions about the necessity of allowing for the sovereign rights of states and the compatibility of activities in the field of DBS with the development of mutual understanding and the strengthening of friendly relations and cooperation among all states and peoples in the interests of maintaining international peace and safety. Among the principles approved by the General Assembly is the applicability of international law, including the United Nations' Charter, to direct television broadcasting, the responsibility of states for their activities in the field of DBS, and the need for peaceful resolution of any disagreements that might arise.

The adoption of the document regulating the use of artificial Earth satellites for direct television broadcasting, which by its nature is a code for space television, was an important contribution to strengthening law and order and the further development of international space law.



11746
CSO: 1866/124

INTERNATIONAL SPACE ORGANIZATIONS

Moscow ZEMLYA I VSELENNAYA in Russian No 2, Mar-Apr 83 pp 23-27

[Article by Ye.P. Kamenetskaya, candidate of juridical sciences, and S.A. Nikitin, member of the USSR Academy of Sciences "Intercosmos" Council]

[Text] The Soviet Union has been the initiator of extensive international cooperation and the development of a firm legal basis for it since the very first days of the space age. The course toward further expansion of international cooperation in space research was confirmed at the 26th CPSU Congress. The need for cooperation in space research results from objective causes of an economic, social and political nature.

International cooperation in space research and the use of space is effected on a bilateral and multilateral basis. The activities of the international organizations are the most extended in this field.

Dozens of international organizations are now connected with the coordination of efforts in space research. International cooperation in space research and the use of space also takes place today through international organizations that do not have as their main purpose joint efforts in space research (for example, the United Nations and some of its specialized institutions and other organizations), and through international organizations whose main purpose is to develop international cooperation along the most varied avenues of space research and the use of space. It is this group of organizations that is usually called the international space organizations.

These organizations include the International Organization for Maritime Satellite Communications (INMARSAT), the "Intersputnik" International Space Communications Organization, the International Organization for Telecommunications via Artificial Earth Satellites (INTELSAT), the European Space Agency (ESA), and also the Committee on Space Research (COSPAR); and also the International Astronautical Federation (IAF), the International Academy of Astronautics (IAA), the International Institute of Space Law (IISL), and others.

The science of international law does not have a single set of generally recognized criteria for classifying the international organizations. Nevertheless, certain principles of classification can be proposed.

Thus, on the basis of the criterion of membership, these organizations should be divided into two categories: intergovernmental space organizations (these now include INMARSAT, "Intersputnik," INTELSAT and ESA; there are about 30 all together), and nongovernmental space organizations (COSPAR, IAF, IAA, IISL; a total of about 20).

Among the international organization it would be possible to distinguish those whose purpose is to discuss various problems connected with space research and hold various kinds of discussions and conferences (COSPAR, IAF, IAA, IISL), and organizations whose purpose is to combine efforts for practical activities associated with space research (INMARSAT, "Intersputnik," INTELSAT, ESA).

The intergovernmental space organizations also include those whose charters provide for the possibility of universal membership without any kinds of restrictions (INMARSAT and "Intersputnik"), and those in which membership is restricted, which contradicts the principles and standards of international law and internatioanl space law (INTELSAT, ESA).

Although the United Nations is not an international space organization "in the pure sense," its role in international relations, including in the field of cooperation in space research, is significant and unique.

Several subdivisions have been set up within the UN framework to coordinate cooperation among states in space research and the use of space. Among these, first and foremost we should distinguish the Committee on the Use of Space for Peaceful Purposes--an auxiliary organ of the UN General Assembly.

The UN committee on space, which started its practical activity in 1961, came into being on the initiative of the USSR. The initial membership was 24 states. Today it includes 53 countries.

The UN committee on space is made up of two subcommittees--legal and scientific and technical--set up in 1962. If required the committee can set up working groups to study specific questions.

In the legal subcommittee the main activity is the drawing up of drafts for multilateral agreements regulating relations resulting from space research. It is in this subcommittee that efforts are concentrated to coordinate the positions of states and achieve mutually acceptable solutions.

The activity of the science and technology subcommittee includes the exchange of information on space research, stimulating international space programs, cooperation in developing applied satellite systems, personnel education and training, observing international sites, registration of space objects, and environmental protection.

Before describing in detail the legal status and activity of the nongovernmental space organizations, we note that they constitute an important element of present international relations. The nongovernmental space organizations came into being earlier than the intergovernmental organizations, and for some time participation in their work was the only way for scientists in different

countries engaged in work on the problems of cosmonautics to meet. The nongovernmental space organizations do not conduct research and experiments but their activities promote the broad exchange of information and the discussion of various scientific problems and the strengthening of international cooperation, and they therefore enjoy great authority in the world scientific community. By promoting the expansion of contacts between scientific organizations and individual scientists in countries belonging to different sociopolitical systems, the nongovernmental organizations make a significant contribution to the transformation of space into an arena of fruitful international cooperation.

The International Astronautical Federation was formed as an organization in 1952, when its first charter was adopted. However, the date of the IAF's founding is considered to be 1950 because it was in that year that the representatives of eight astronautics and rocket societies in Austria, Argentina, Great Britain, Denmark, Spain, France, the FRG and Sweden gathered in Paris and decided to found an international organization to deal with the problems of space flight.

Now, the basis of the IAF's activities--the 1961 charter--includes changes introduced in 1968 and 1974. IAF activities particularly increased after the launch of the first artificial Earth satellite.

The IAF examines technical problems, including questions concerning engine development and the design of space vehicles, and various sociopolitical and legal aspects of space research and the use of space. The IAF is the only nongovernmental space organization that covers such a broad and varied range of problems arising in connection with space research. In accordance with its charter, the activity of the IAF is aimed at promoting the development of astronautics for peaceful purposes, facilitating the dissemination of information on space research, cooperating with national and international organizations on technical and social and legal matters concerning space research, encouraging public interest in these problems, and holding international astronautical congresses, symposia and colloquia. Some 58 national astronautical societies in 36 countries now belong to the IAF. Soviet scientists have been participating in IAF activities since 1955. Since 1976 their interests in the IAF have been represented by the USSR Academy of Sciences "Intercosmos" Council.

The IAF's highest organ is the General Assembly. In the intervals between meetings of the General Assembly IAF activities are guided by a bureau made up of a president, five vice-presidents and the last retired IAF president. The presidents of the International Academy of Astronautics and the International Institute of Space Law, and also the IAF general counsellor, are nonvoting members of the bureau.

It is especially emphasized in the charter that election of the leaders of IAF organs should be held taking into account the contributions of countries to space research and the use of space and the principle of fair geographical representation.

Several standing committees have been set in the IAF, including committees on bioastronautics, applied satellites, educational questions, publications and others.

Since 1950 the IAF has held annual international astronautical congresses that attract the attention of scientists and specialists in many states. In 1973 the congress took place in the USSR (ZEMLYA I VSELENNAYA No 2, 1974, p 53--ed). The astronautical congresses are attended by hundreds of scientists from virtually all the countries doing work in the field of space research and the use of space. At recent congresses there has been discussion of problems such as the use of space technology for meteorology, communications, studies of the Earth's natural resources and other practical needs, the development of manned orbital stations and space transportation systems, the use of solar power, and insuring normal conditions for man's activities in space flights.

Since 1973 the IAF congresses have been devoted to the discussion of some main theme. Thus the main problem for the 1973 IAF congress was studies on the effect of space research on science and technology; the 1978 IAF congress, held in Dubrovnik (Yugoslavia) took place under the theme of "Space in the Service of Peace and Human Progress"; while the 33d IAF Congress, which took place in Paris 26 September through 2 October 1982 was held under the slogan "Space in the Year 2000." The IAF has been afforded the status of observer in the UN Committee on space.

In 1960, within the frameowrk of the IAF and under its leadership two new scientific organizations were set up--the International Academy of Astronautics and the International Institute of Space Law. The charters of these organizations were approved at the 11th IAF Congress and amendements have since been made several times.

The International Academy of Astronautics promotes the holding of scientific meetings and research and the preparation of reports dealing with the problems of developing astronautics. It also publishes a journal and other scientific works and awards prizes and medals.

The academy was created on the basis of individual membership. It is made up of scientists who are well known for their services in the field of cosmonautics. The membership is now about 550 specialists from more than 30 countries.

There are two categories of academy membership, full member and corresponding member. Both groups are considered to be academicians but the right to vote is restricted to the full members. Members are elected for life.

The highest leading organ of the academy is the council of trustees, consisting of a president, four vice-presidents and the last retiring president, plus 12 other members.

The academy's most popular publication is the journal ACTA ASTRONAUTICA.

The International Institute of Space Law was set up to replace the IAF permanent legal committee that had existed earlier. The institute has as its purpose the study of the legal and sociological aspects of space activities, the organization of annual colloquia on space law which take place simultaneously with the IAF congresses, conducting studies and preparing reports on the legal questions of space research, publishing various kinds of materials on legal questions of space research, publishing various materials on space law, and awarding prizes. It is also engaged in questions of teaching space law. The institute is the only nongovernmental organization where the legal, political, social and economic problems of space research are discussed.

The institute was set up on the basis of individual membership. Institute members are elected for life. The institute membership is now about 400 scientists from almost 50 countries.

The work of the institute is directed by a council of directors made up of 20 members. In election of the council members consideration is given to the principle of adequate representation for the various legal systems in the world.

The International Institute of Space Law represents the IAF in the legal subcommittee of the UN committee on space.

Since 1956 when the first colloquium on space law took place, the institute has published an annual collection of reports presented at the colloquia organized by the institute, together with various information on institute activities.

The Committee on Space Research (COSPAR) was created on the initiative of the International Council on Scientific Unions in October 1958. It was to continue with measures on cooperation in space research following the International Geophysical Year [IGU]. COSPAR was initially set up through the rights of a special committee of the International Council on Scientific Unions, the organizations on whose initiative the IGU took place.

Successful cooperation among scientists from different countries within the framework of the IGU (1957-1958) demonstrated the effectiveness of the new organizational forms in studies of the Earth and circumterrestrial space. About 30,000 scientists and specialists from 67 countries participated in the IGU program under the aegis of the International Council on Scientific Unions; they worked on 13 sections in the program (seismology, gravimetry, oceanography, meteorology, glaciology, cosmic rays, physics of the ionosphere, solar activity and so forth). Naturally, the idea arose of continuing international cooperation in the study of space and of combining the efforts of scientists in different countries within the framework of an international organization that would coordinate scientific research conducted with the aid of rockets, satellites and space vehicles, organize a broad exchange of information from the results of this research, and offer recommendations on the most purposeful and promising avenues for future research.

It was COSPAR that paved the way for effective international cooperation in the study of space. Although COSPAR was set up later than the IAF, it in fact

became the first nongovernmental organization specially created to encourage and develop international cooperation in space research and the use of space.

It was noted in the resolution of the International Council on Scientific Unions dealing with the creation of COSPAR that the main purpose of the new international organization is "to afford scientists throughout the world the opportunity for the broad use of satellites and space probes for scientific research in space and the organization of the exchange of information on research findings on the basis of reciprocity." It should be emphasized that COSPAR is engaged mainly in basic scientific research conducted with the aid of rockets, satellites and space vehicles.

COSPAR unites within its ranks the academies of sciences and equivalent national scientific establishments in 34 countries. The USSR Academy of Sciences, which has been a COSPAR member since 1959, has invariably actively participated in the activity of this organization.

Since November 1958 when the first session took place in London, COSPAR and its executive committee have met annually. At the first sessions the structure of COSPAR was formulated and a charter for the organization was drawn up and adopted (January 1960) and its style of work defined. Of course, during the years of its existence COSPAR has undergone certain changes connected with general progress in the study of space, the expansion of the areas of space research and new avenues of research.

COSPAR's highest organ is the plenum which was held (until 1980) annually during the period of the session. In the intervals between plenums the scientific and organizational activities of COSPAR are guided by the executive committee which is made up of a president, two vice-presidents and four members who form a bureau and are elected for a 3-year term, and also representatives of the international scientific unions in the International Council on Scientific Unions who are COSPAR members.

In accordance with the charter, the method used to elect the president, two vice-presidents and four other members of the council should insure representation "corresponding to the distribution of main efforts in space research and the use of space by the COSPAR members." Within COSPAR a special method unique to this organization alone is used to elect officials. The COSPAR charter contains a special provision that one vice-president is elected from a number of candidates representing the USSR Academy of Sciences, while the other is elected from a number of candidates representing the U.S National Academy of Sciences. Two of the bureau members are elected from a list of candidates proposed by one vice-president, and the other two from a list put forward by the other vice-president. The president is elected from a list of candidates proposed by the council or directly at a general meeting.

COSPAR maintains contacts with international organizations whose activities are connected with effecting international cooperation in space research and the use of space. In 1961 COSPAR was granted consultative status in the UN committee on space.

COSPAR publishes an information bulletin and the transactions of the regular sessions.

COSPAR's scientific and organizational activities take place within the framework of specialized working groups covering the main avenues of space research. Open meetings of the working groups and symposia, whose themes reflect the most urgent problems in the development of space sciences and in whose organization interested scientific unions particpate, are held annually at the COSPAR sessions.

The general interest in space research over the last two decades has been reflected in COSPAR's structure and its working procedures. Whereas at first COSPAR had only three working groups and the sessions during the first decade usually included one or two symposia, at the 12th session in May 1969 in Prague a new structure for the working groups, whose number was increased to seven, was adopted; and this was finalized at the 13th session in Leningrad in 1970. The number of symposia on the most urgent problems of the space sciences also grew. For example, the program for the 21st COSPAR session (1978 in Innsbruck, Austria) included eight symposia devoted to solar and Earth physics, X-ray astronomy, gravitational physiology, remote atmospheric sounding from space, and other avenues of space research.

The structure and procedures for COSPAR work described above existed until 1980, when a transition was made to a new structure and a new working procedure. These changes are basically as follows. Beginning in 1980 it was decided to hold COSPAR sessions once every 2 years. The same period was decided upon for the executive council, while the bureau will meet at least once a year.

Instead of the working groups a system of interdisciplinary scientific councils was adopted to hold thematic meetings during the COSPAR sessions. The system of interdisciplinary scientific councils now includes seven commissions: "Studies of the Earth's surface from space, meteorology and climate," "Space studies of the Earth-Moon system and the planets and small bodies in the solar system," "Space studies of the upper atmospheres of Earth and the planets, including atmosphere models," "Space plasma in the solar system, including the magnetospheres of the planets," "Astrophysics research in space," "Space biology" and "Materials science in space."

As before, an important role in COSPAR activities is assigned to the symposia and seminars organized by the international scientific unions and included in the program of work for the sessions. At the 23d COSPAR session in Budapest in June 1980 there were eight symposia devoted to the successes in planet studies, active experiments in space, cosmic rays in the heliosphere, the physics of planetary magnetospheres, the first results from observations in the PIGAP [program to study global atmospheric processes] program [ZEMLYA I VSELENNAYA No 3, 1975 p 38--ed], theoretical problems in high energy astrophysics, prospects for the use of aerostats during the Eighties, and a comparative study of planetary interiors. The 24th COSPAR session took place in Ottawa (Canada) 16 May through 2 June 1982.



9642
CSO: 1866/115

LAUNCH TABLE

LIST OF RECENT SOVIET SPACE LAUNCHES

Moscow TASS in English or Russian various dates

[Summary]

| Date | Designation | Orbital Parameters | | | |
|---|---|---|---|---|---|
| | | Apogee | Perigee | Period | Inclination |
| 5 Oct 83 | Cosmos-1502 | 411 km | 372 km | 92.3 min | 75.9° |
| 12 Oct 83 | Cosmos-1503 | 827 km | 791 km | 100.9 min | 74° |
| 14 Oct 83 | Cosmos-1504 | 328 km | 180 km | 89.3 min | 64.9° |
| 20 Oct 83 | Vertikal'-11 | (Geophysical rocket launched from European area of USSR; carries instruments for solar research designed by USSR, Poland and Czechoslovakia; instrument container separated at altitude of 95 km and returned by parachute) | | | |
| 21 Oct 83 | Cosmos-1505 | 377 km | 210 km | 90 min | 72.9° |
| 21 Oct 83 | Progress-18 | 269 km | 193 km | 88.8 min | 51.6° |
| | | (Automatic cargo ship launched to resupply "Salyut-7" station) | | | |
| 26 Oct 83 | Cosmos-1506 | 1,026 km | 969 km | 104.8 min | 83° |
| 28 Oct 83 | Meteor-2 | 901 km | 780 km | 101 min | 81.2° |
| | | (Meteorological satellite to obtain global images of cloud cover and earth's surface in visible and IR range both in memory and direct transmission modes; data to be received at State Research Center for Study of Natural Resources and USSR Hydromet Center) | | | |

| Date | Designation | Orbital Parameters | | | |
|---|---|---|---|---|---|
| | | Apogee | Perigee | Period | Inclination |
| 29 Oct 83 | Cosmos-1507 | 449 km | 431 km | 93.02 min | 65° |
| 11 Nov 83 | Cosmos-1508 | 1,064 km | 400 km | 108.8 min | 83° |
| 17 Nov 83 | Cosmos-1509 | 309 km | 209 km | 89.3 min | 72.9° |
| 23 Nov 83 | Molniya-1 | 39,150 km | 465 km | 11 hrs 42 min | 62.8° |
| | | (Communications satellite for long-range telephone, telegraph and radio communication and for TV broadcasts in the "Orbita" network) | | | |
| 24 Nov 83 | Cosmos-1510 | 1,537 km | 1,497 km | 116.1 min | 73.6° |
| 30 Nov 83 | Cosmos-1511 | 368 km | 181 km | 89.7 min | 67.2° |
| 30 Nov 83 | Gorizont | 35,850 km | -- | 23 hrs 59 min | 1.4° |
| | | (Communications satellite for further development of systems of communication and TV transmission using artificial satellites; near-stationary circular orbit) | | | |
| 7 Dec 83 | Cosmos-1512 | 392 km | 208 km | 90.2 min | 72.9° |
| 8 Dec 83 | Cosmos-1513 | 1,029 km | 977 km | 105 min | 83° |

CSO: 1866/51-P

- END -